MOTOR BODY BUILDING

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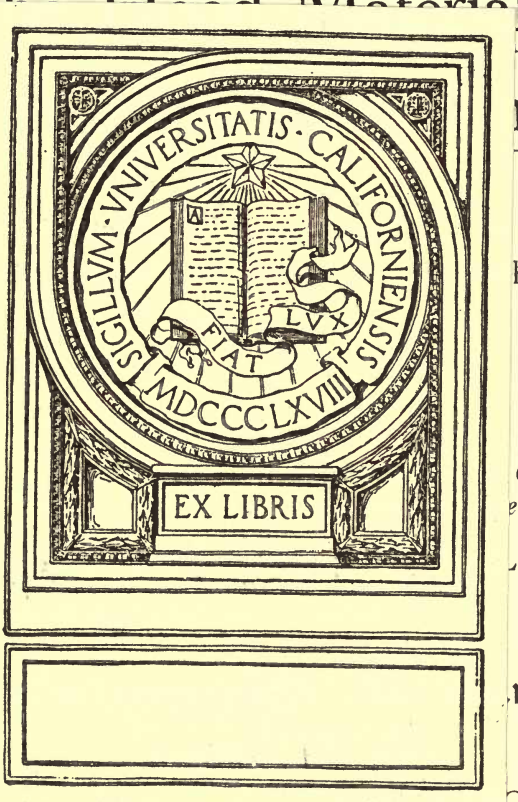

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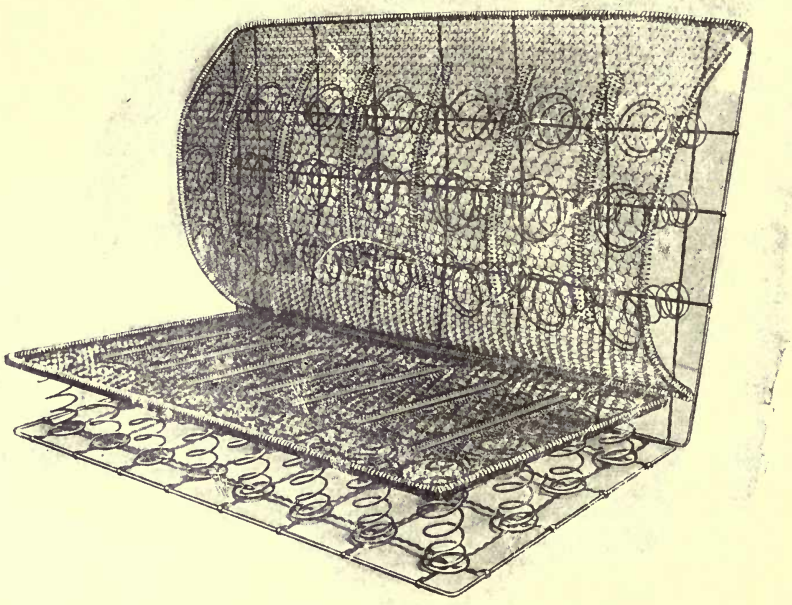

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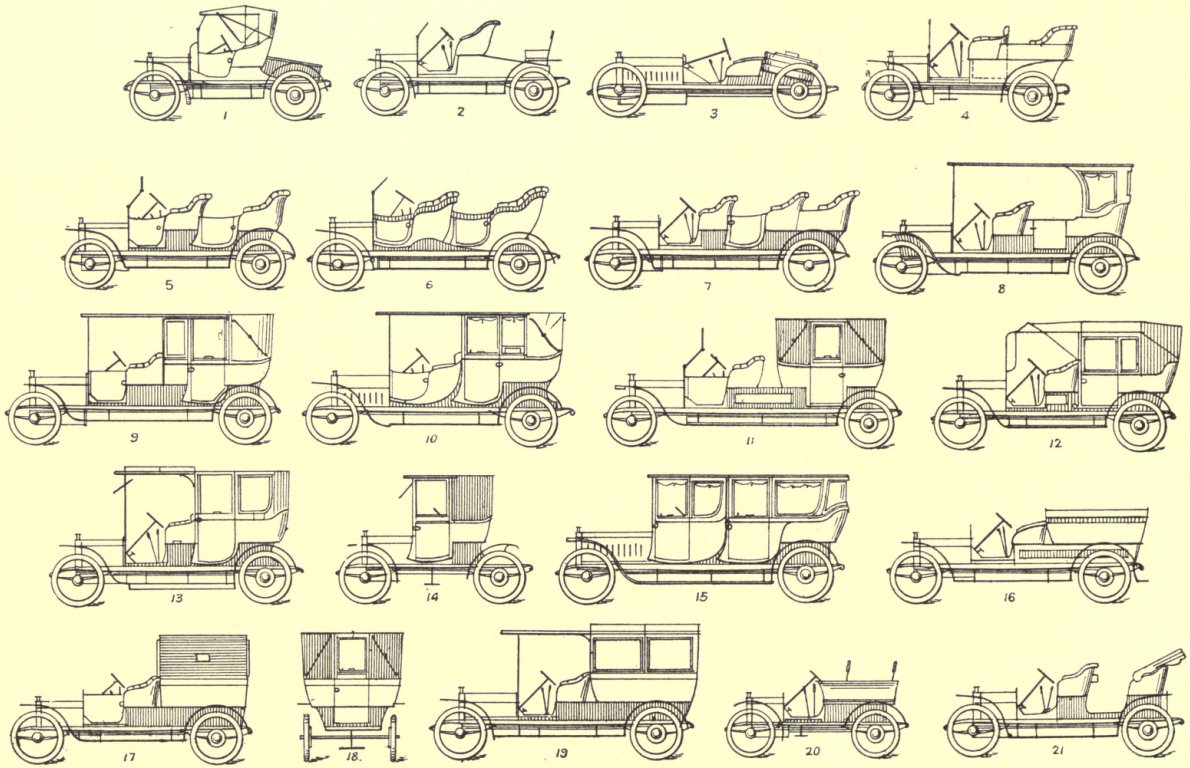

VARIETIES OF MOTOR BODIES

(*See* CHAPTER I)

MOTOR BODY-BUILDING

IN ALL ITS BRANCHES

BY

C. W. TERRY

ORGANIZER AND INSPECTOR OF THE CITY AND GUILDS OF LONDON INSTITUTE

With Additional Matter

BY

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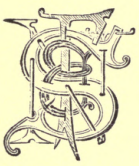
With 50 Plates and many Illustrations in the text



London

E. & F. N. SPON, LIMITED, 57 HAYMARKET

New York

SPON & CHAMBERLAIN, 123 LIBERTY STREET

1914

CONTENTS

PREFACE

In presenting this work to those who are interested and connected with the trade of carriage building and the newer industry of motor body work, it is desirable that not only will it serve as a textbook for general use, but also assist the technical student in his preparation for the Examinations yearly held by the City and Guilds of London Institute.

In bringing together the matter in order that the particular subject should contain that which is both instructive, practical and useful, it may be noticed how largely we are indebted to the excellent trade journals existing in this country as well as abroad.

Some reference has also been made to Birge and Sargent's *Practical Problems for Vehicle Makers*, published by Ware Brothers Company, Philadelphia.

Among others who have been generously interested in the production of this book is Mr. H. J. Butler, Technical Editor of the *Automobile and Carriage Builders' Journal*, and though circumstances, rather than a desire on my part, are largely responsible for the present issue, I feel that after twenty-five years of active work in technical teaching in the coach trade the book should serve a most useful purpose.

C. W. TERRY.

Newport Pagnell.

September 28, 1914.

CHAPTER I

THE VARIETIES OF MOTOR BODIES

In a study of an art or craft, it is always helpful to have some definite classification under which the several objects to be considered may be arranged. By this means the subject may be attacked systematically, an advantage which increases in value according to the breadth of the particular study in hand. The number of kinds of vehicles which are running about our streets day by day is very great, and these varieties continue to be added to, as the requirements of commerce and transportation dictate.

The coming of the automobile has seen a great increase in the varieties of road vehicles during the last few years, and I propose in this chapter to see into what classes these new types may be conveniently arranged.

1. **Two-seated Cars or Single Phaetons.**—These have a single seat in front capable of holding two persons, which may be divided or constructed as two separate bucket seats. Recent types have high wind doors, raked steering column, low driving seat, and curved dash-board (scuttle-dash).

A two-seated car generally has a tool box of some description at the rear, as the room taken up by the seats is always insufficient to occupy even the most compact chassis which has to arrange for the attachment of four wheels. This rear portion is often made detachable. A two-seated car may be protected by a cape-hood of waterproof twill or leather substitute, and it may also have a proper enamelled folding leather head with cloth lining. The sticks of the hood should be so arranged so as to give the best possible entrance. Canopies are seldom fixed now. (Fig. 1.)

2. **Three-seated Cars.**—This is a class of body which may be considered as having a main seat carrying two persons, while a further seat, either of the fixed or collapsible type, is fitted for emergencies. Usually this seat is found in the rear, and the presence of the "torpedo" or tool-box portion allows of this seat being easily stowed away. Some earlier types of cars, owing to the disposition of the engine, were able to have an extra seat facing the driving seat, making practically a *vis-à-vis* phaeton. The weather protection is generally restricted to the main and driving seat. (Fig. 2.)

3. **Racing Cars.**—Closely allied to the two-seated car is the racing car, a distinction which is not so marked now, owing to the racing appearance

given to the body work on chassis of comparatively low horse-power. The racing body may generally be distinguished by the absence of all unessentials, and is often without any weather protection, wings, doors, steps, lamp irons, handles, and other fittings, a large petrol tank, commodious spare tyre accommodation, scanty painting and trimming. (Fig. 3.)

4. **Tonneaux (Hind Entrance).**—This was the leading type of motor in the earlier years of motoring, owing to the short wheel-bases of the chassis then manufactured. The body consists of a driving seat or seats, holding two persons, and a rear portion, which, starting with the widths at the back of the driving seat, swells out towards the rear, so that two persons are accommodated in the hind corners, and at the same time a minimum width of entrance is provided. The bodies are sometimes fitted with canopies, and cape-hood folding from a single centre. The hind entrance tonneau is sometimes constructed with a removable top, having lights all round, which are fixed, sliding, or folding, as the shape of the lower portion of the body prevents the glasses dropping. This type of body is practically a limousine, as will be shown later. The fixing of the top often includes a roof extension to the dashboard, where it is supported by two brass tubular stanchions. (Fig. 4.)

4*a*. **Tonneaux (Swing Front Entrance).**—As a compromise to the inconvenience of stepping into the roadway to gain admission to the main portion of the body in a hind-entrance body, several were made with a swing front entrance, whereby the near-side driving seat was made to hinge with part of the side panelling. Some recent types of "torpedo" bodies are made in this way. (Fig. 5.)

4*b*. **Tonneaux (Front Entrance).**—Another means of eliminating the disadvantages of the hind entrance was the adoption of a front entrance, whereby the near-side half of the driving seat hinged either inwards or outwards, so as to leave a free gangway to the rear portion of the body. This type of entrance is also used in some limousines, landaulettes and other types, while in a few instances, to simplify the entrance, the near-side seat is done away with. (Fig. 5.)

5. **Tonneaux (Side Entrance).**—The types of entrances described under Nos. 4*a* and 4*b* proved, on the whole, unsatisfactory, and the public demand was for a proper side entrance, as many motorists had already been used to in their horse carriages. To this end larger wheel bases were designed and the tonneau pushed further back, and a side entrance with doors constructed. (Fig. 5.)

6. **Side-entrance Phaetons.**—There is no doubt that the full title for a "tonneau" is "tonneau phaeton," in the same way that a victoria is, properly speaking, a "victoria phaeton." The term phaeton has a very wide and, it must be admitted, loose application, and it seems that almost any body having a transverse seat or seats, and mounted on two axles, comes under this heading. It is generally understood now that a side-

entrance phaeton is a motor body in which the rear portion accommodates two and often three persons on a hind transverse seat. Extra seats in this portion of the body, either facing forwards or fixed on the front lining boards, do not alter its name, except that the term "triple phaeton" and "double phaeton" are sometimes used as mentioned later. The fact that "tonneau" is only half the title is perhaps made clearer when the horse-drawn "tonneau phaeton" is considered, which is a term generally agreed upon by those carriage-builders who have been constructing during the last year or two a side-entrance body having a tonneau shape at the rear and with an arch under the front seats to allow for the lock of the fore-carriage. Many side-entrance phaeton motor bodies are made with a continuous side sweep from the back of the driving seats, with or without round hind corners. In these instances the drop of the adjective "tonneau" is perhaps justified. The motor manufacturer's standard body is generally a side-entrance tonneau phaeton. In hind-entrance bodies step treads were sufficient, but with the adoption of side entrances platform steps have been almost universally adopted, except in a few instances, such as electric town carriages, etc. The side-entrance phaeton is usually provided with a double extension head, which is erected on front and hind sets of neck plates, but is lowered from the hind centres only. Canopies are seldom seen, but leather hoods, either to the back only or both back and front, are sometimes seen, especially the former. (Fig. 6.)

6*a*. **Torpedo and Boat Bodies.**—A recent type of side-entrance phaeton is that which follows much after nautical lines some bodies follow almost exactly the side sweep of a boat, while others are simply ordinary phaetons built low with a shallow panel below the elbow. (Fig. 6.)

7. **Triple Phaeton.**—The side-entrance phaeton may have folding seats fitted to the front lining boards, or if it is long enough these seats may be arranged facing forwards, which, if formed into seats fastened permanently to the main side framework of the body, are sometimes known as triple phaeton. (Fig. 7.)

8. **Protected Phaetons.**—This type of body, also called a demi-limousine, consists of a side-entrance tonneau or phaeton body, with the rear seats protected by fixed panelling at the sides and back, provided with lights. The back one is usually fixed, while the side ones may be hinged occasionally. The roof extends to the dashboard, and a hinged frame is often fixed behind the driving seat. (Fig. 8.)

The Turnunder Pattern.—Two-seated cars and bodies of all descriptions may also be sub-divided according to the shape given to the turnunder of the seat panels. This may either be (*a*) the plain type, where the turnunder is effected by a straight line; (*b*) the rotund, where a curved line having its fullness at the bottom is used; (*c*) the tulip, which is rotund shape reversed; and (*d*) the Roi-des-Belges, which is a combination of both (*b*) and (*c*), and consists of a graceful return sweep. These four patterns of turnunder are

seen at their best when used with moderation, a remark which applies particularly in the case of the Roi-des-Belges pattern.

8*a*. **Single Brougham.**—A motor single brougham body follows as near as possible the lines of the horsed prototype. It should have either single or double front lights, which may drop, slide, or fold, drop lights in the doors, and "upper quarters panels without lights." An extension roof canopy to the dash-board may be fitted, and the description is synonymous with the French term *coupé*.

8*b*. **Double Brougham.**—There are few motor single broughams about, and the number of these broughams constructed with a front either of the D, circular, or square shape is fewer still. A few electric carriages are so constructed.

8*c*. **Single Landaulettes.**—The single landaulette has a driving seat of the usual pattern, with a main body portion provided with side doors immediately following the driving seat, and must at least be fitted with a folding hood so as to make the remaining part of the body open above the elbow, and beyond the hind standing pillar. The single landaulette may in the larger patterns be fitted with extra seats on the front lining boards. The headwork may also be constructed so as to provide for the entire collapsing of the superstructure above the elbow line.

A single landaulette may open in the following ways :—

(*a*) Cant rail cut close to front standing pillar and front pillar tops fixed.
(*b*) Cant rail lifting off at top of front pillar tops and front pillar tops to fold inwards on to front fence rail.
(*c*) Cant rail as in (*b*) and front pillar to fold forwards on to lamp irons.
(*d*) Cant rail cut as in (*a*) or (*b*) and also hinged in centre so as to fold inwards when down.
(*e*) Brougham doors used, roof fixed as far as split pillar top.
(*f*) A fixed front may have an extension fitted, and a removable extension on separate stanchions may be fitted in other instances.

9. **Double Landaulettes.**—The landaulette bodies mounted on chassis generally have either a D or square front. The circular front is seldom used, as it detracts from the accommodation. When a D-front is used, the only means of increasing the ventilation at that point is by dropping the flat centre glass frame. When a square front is used the side and front lights may drop, the front light pillar tops may fall forward or inwards, and completely reversed inside the body. The hind standing pillar top may be hinged to the various forms of cant rail as described under single landaulettes, and the same remarks as to extension canopy applies also. (Fig. 9.)

10. **Limousine Landaulettes.**—Extra side light Landaulettes, three-quarters Landaulettes, or sometimes called Double Landaulettes :—

This type of body has a side light beyond the main side doors, and, according to the length of the design, it may have seats either on the front lining

boards or two single seats facing forwards. As regards the schemes of opening the head, it may simply fall behind the hind standing pillar, or it may further or completely collapse by folding the side light pillar tops either downwards into the body or along the fence of the light, while if the front collapses the pillar tops fold across the front fence. The remarks as to extension canopies apply also to single landaulettes. Limousine landaulettes are sometimes made with a square front. (Fig. 10.)

11. **Landaus.**—The landau body, owing to its length and the space required for the front and its headwork to fold, has been little favoured as a motor body, especially when the engine is in front of the dash-board. It has been chiefly used for electric cars, and petrol chassis where the engine has to be accommodated under the driving seat. A landau body, to be properly so called, must have both upper quarters to fold outwards, and capable of meeting in the centre over the doorway and being locked together. Where the hind leather quarter only falls the body is a double landaulette, providing there is a seat between the main doorway and the driving seat. Broughams, landaulettes, and limousines may be built with the whole of the superstructure to be lifted off bodily above the elbow line, when the remaining portion would be properly described as a side-entrance phaeton. (Fig. 11.)

12. **Landaulette Phaetons.**—A recent type of body is called a landaulette phaeton. This is a side-entrance phaeton, having a superstructure very much after the style of a Cape-cart hood, but possessing some of the solidarity of the landaulette headwork. The landaulette phaeton may be either single or double, the latter term being applied when a side light is used. The protection capable of being all folded down from a hind centre may extend over the driving seat to the dash-board. These bodies differ from the ordinary side-entrance phaeton with a double extension Cape-cart hood in that there are pillar tops above the elbow line, and proper glass frames dropping into runs. The landaulette phaeton is most commonly known as the " Cabriolet " design. (Fig. 12.)

13. **Limousines.**—Although a few of the earlier limousines were made with front and hind entrance, it may now be assumed that all bodies now built have side entrances. A limousine has a side sweep in plan, but is seldom of the tonneau shape,while the presence of a quarter light differentiates it from a brougham. The seating is arranged at right angles to the length of the car ; if arranged parallel with the length of the car, it is an omnibus. Small limousines are also known as coupé limousines, while the larger types, seating up to nine in the body, with a corridor entrance to the driving seat, are known variously as saloons and Pullman's. The term *Berline* is generally restricted to a large limousine having lights all round the body above the elbow. Limousines are sometimes built with a square or D-front. (Fig. 13.)

14. **Enclosed Cars (Single).**—This is a class of motor body, where the driving seat is entirely enclosed, and follows after the style of a posting vehicle. An extra seat may be arranged behind, generally to fold into a

torpedo back and usually unprotected. The superstructure may be a brougham, limousine, or landaulete type. (Fig. 14.)

15. **Enclosed Cars (Double).**—This is a class of body where a limousine or landaulette proper has the driving portion enclosed as well. A modern form is the Streamline Pullman's Saloon. (Fig. 15.)

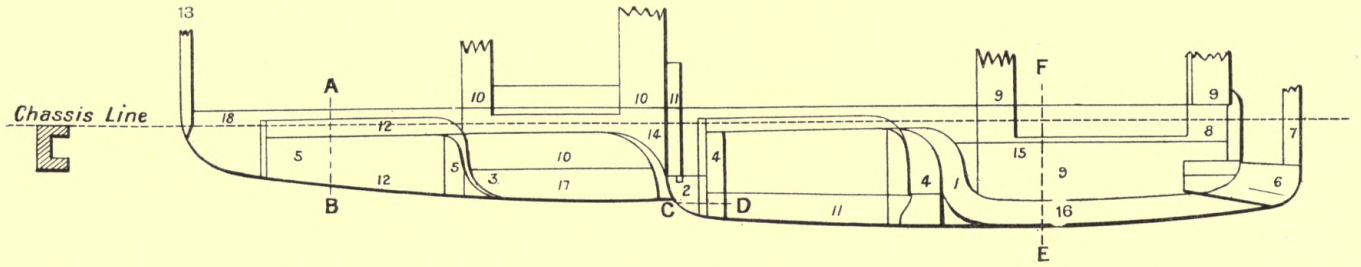
16. **Wagonettes.**—This type of body should have longitudinal seats placed *vis-à-vis* in the main portion of the body and usually with a hind entrance, although some varieties have side doors as well. A shooting brake is a wagonette provided with game and gun racks, and accommodation for ammunition. A luggage brake, or estate wagon, is often a wagonette with the long seats made to fold flat against the side of the body and the hind entrance provided with double doors. (Fig. 16.)

17. **Lonsdale Wagonettes.**—The Lonsdale wagonette is practically a wide landau body turned at right angle to the driving seat. Strictly speaking it is, of course, a landau. (Figs. 17, 18.)

18. **Private Omnibuses.**—This is a body as described under No. 16, provided with a solid top, suitably glazed, which may be made removable if required, so as to form a wagonette. (Fig. 19.)

19. **Dog Cart Phaetons.**—This is a body where the character of a road or self-driving phaeton of the horse type is preserved, but it is seldom seen now. (Fig. 20.)

20. **Double Phaetons.**—The double phaeton is practically a side-entrance phaeton without doors, and the hind seat should be more or less a repetition of the driving seat. The term " Surrey " is an American equivalent. The modern departure in these bodies is to have doors fitted back and front, the panels continued down to the runners, and the addition of a scuttle dash, this forms the well-known flush-sided torpedo body, as there is a minimum of wind resistance. (Fig. 21.)



KEY TO CANT BOARD (viewed from the top).

(1) *Hind standing pillar.*
(2) *Front.* ,, ,,
(3) *Front sham door pillar.*
(4) *Side door pillar.*
(5) *Front* ,, ,,
(6) *Hind corner.*
(7) *Back rail.*
(8) *Hind bar.*
(9) *Rear seat framing.*
(10) *Front seat framing.*
(11) *Door bottom and top rails.*
(12) *Front door bottom and top rails.*
(13) *Front cross rail.*
(14) *Corner pillar of front quarter.*
(15) *Top line of recessed seat rocker.*
(16) *Elbow or waist line.*
(17) *Front elbow piece.*
(18) *Bottom runners.*

CANT OF A SIDE ENTRANCE PHÆTON BODY.

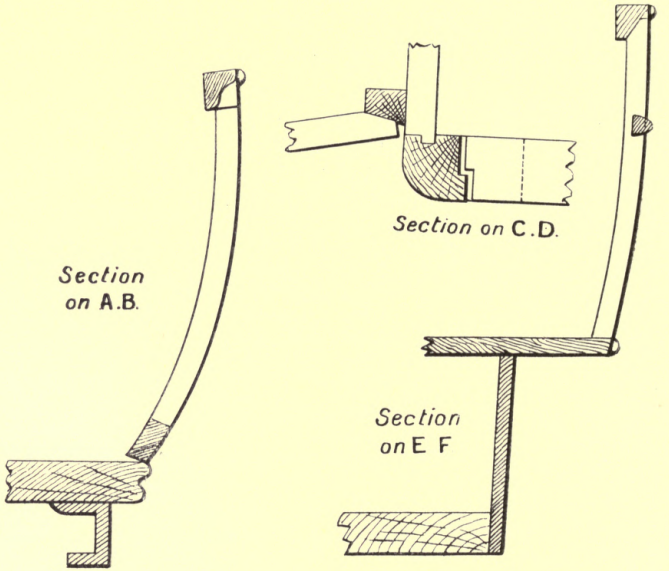


PLATE I.

CHAPTER II

THE CANT BOARD

The cant board of a motor body (Plate I) is the plan of one side of the body viewed from the top, showing the cross sections together with the underside of the same pieces of framing. This drawing is needed, as though we have a drawing of the side-view of the body, it does not always give the real shape and size of the framework, since motor bodies are built on lines that are curved both in a vertical and horizontal direction at one and the same part. The curvature of the body downwards is called the *turnunder*, that of the side the side-sweep or *cant*. If a line or a piece of framing is made running straight outwards or inwards, that is then called the contraction line, therefore all cross bars or rails standing square or straight across, their joints or shoulder in relation to these pieces, shown on the cant board, must be at an angle, that is the shoulders are bevelled possibly in two directions, thus the exact length and bevels of all pieces can be taken. The cant is really the view of one side of body seen on the horizontal plane, and is thus a sectional ground plan. It is impossible to construct a difficult piece of work with precision, accuracy, and correct form, design or measurement, without its use, because apart from the size and shape of framing being shown by it, the form of joints most suitable can be clearly seen and frequently the best method of securing the particular joint. The advantages of side sweep and turnunder in their relationship to all types of body-work may not be readily grasped. But they are: 1st. To allow width to a body where it is wanted (*the seat*) and to contract it where it is not wanted (*the chassis*). As a case in point we frequently have 4 ft. 3 in. inside on the seat, with a chassis frame 3 ft. 8½ in. wide only. 2nd. That while appearance and proportion are main points in an elegant and graceful body, curved and rounded surfaces are much better for paint and varnish. 3rd. The preservation of outline; the outline of body is more attractive to the eye when seen on a curved design, so long as it is not overdone. 4th. A marked reduction is effected in weight, for if the width were maintained in the body without turnunder, the axle, springs, chassis, etc., would all have to be increased in length, with increase of weight, entailing, in motor-cars, increased cost of maintenance, and of the power required to drive the car, which again means more wear and tear. In some motor bodies the side-sweep and turnunder are extreme, in light racing and touring bodies as a rule moderate, but these latter do not require a cant board for mathematical accuracy in construction.

CHAPTER III

THE 3 FT. LINE—THE CHASSIS LINE—THE OUTSIDE EDGE

THE method practised by bodymakers in drawing, or, as it is more commonly called, *making up* their cant, differs in various parts of the country, as it does with different bodymakers, but it must be thoroughly understood that on the accuracy of this cant or plan drawing depends the *speed* and correctness of the work with economy not only in time but also in material. Drawing and working from the 3 ft. line, or the outside edge, or square line, French rule should be understood by skilful men. In coach-work the 3 ft. line is the most common ; in motor bodies this is entirely abolished for the chassis line, the outside edge of the frame deciding the *width* of *chassis frame.* With the 3 ft. line it represents a 3 ft. space in the body (say 56 in.), every other line and point coming inside of this. The outside edge of drawing board represents this 56 in. The *cant board* is usually made of thin pieces of pine, 11 in. to 13 in. wide, smooth with edges shot true, with a line placed on it (in one instance, the 3 ft. line, or in other the chassis line), from which line all cross measurements must be taken. Taking the chassis (bearing in mind we only draw one side, both sides to be alike—thus the framing pieces are in pairs), assuming your body is 50 in. wide, and the chassis frame $32\frac{1}{2}$ in. wide, $32\frac{1}{2}$ from $50 = 17\frac{1}{2}$ in. Thus the point or line of construction is $8\frac{3}{4}$ in. outside the chassis line. The chassis line may rise, drop, or contract back or front. But the square line should go on first to represent the width from which all points and lines are measured and afterwards positioned. *Points :* The necessary points at which all the measurements are accurately marked off, are important. In all cases a full size outline drawing, either with little or much detail is made; at any rate, besides the outline it must give the length from back and front, the position and size of doorways, the length of front seat and dash-board, etc.

CHAPTER IV

PATTERNS AND SWEEPS

It has been previously explained that a side-sweep of body is a regular sweep or curve back to front, on the elbow line or waist rails, its extremities terminating in curved, tangent or straight lines,while the radius of the centre of the curvature of the arc on the elbow line downwards gradually decreases in proportion to the turnunder, thus the side of the body becomes a section of a cone inverted. These long side-sweeps, necessary to get out your material, frame up and *test your work*, should always be *struck out*, not copied, each bodymaker or draughtsman making his own. The bodymaker at the earlier part of his career will gradually make a set of short sweeps of his own. The larger, longer and side and roof sweeps, as a rule, are shop property, being from 5 to 6 ft. in length. The bodymaker sweeps for working are usually made from thin panel board, and go in numbers—1, 2, 3, 4, 5, and so on—the general rule being that No. 1 represents a $\frac{1}{4}$ in. curve in 4 ft.; No. 2, $\frac{1}{2}$ in. in 4 ft.; No. 3, $\frac{3}{4}$ in. in 4 ft.; and so on to No. 12, which is 3 in. in 4 ft. They do not, as a rule, go beyond that, most men only having about a dozen. From the working drawing you will require to make other sweeps. Assuming you have a quick return sweep, say a sham door, or a fish-tail corner pillar pattern, on the line of drawing to be fitted; fix at regular intervals a few needle points, then fit wood up to it. On a chalk drawing, a ruling can be taken off in pencil on cartridge, the proper way to make full size drawings, as they are then always in existence as a record. All shop patterns should be canvassed on one side, and all important lines cut in. Remember time spent on the accuracy of your patterns is time gained in the actual work. *Rams' horns* are useful to a bodymaker, who should have at least three of a graded character for drawing small curves. They are made as follows: Take a piece of thin mahogany, on this fix a disc, such as the lid of a small box, attach a piece of string to the disc, with a sharp pointed pencil at the other end, and strike out by gradually winding the string round the lid; then with a decreased diameter of about $1\frac{1}{2}$ in. to 2 in. repeat the same operation, and cut out to the lines, finishing the ends off as desired.

CHAPTER V

DESIGN OF MOTOR BODIES. FULL SIZE, AND SCALE WORKING DRAWING

It should be quite understood that drawings are not only to show what has to be done, but, when completed, indicate as far as possible how to do it. And drawing takes an important part in our instruction not only because it is the shortest of shorthand, but that senses and faculties are being thereby trained in a direction fitting for our occupation and useful to the coach designer and constructor, so that when called upon to execute work, he is able to discriminate, what is suitable from what is faulty in principle, unsound in application, or wrong in construction.

The scale drawing has two important uses. It is sent or shown to the customer as a means whereby an inquiry is turned into an order, and it forms the preliminary operation before starting on the full-size drawing for the body-maker.

In making a scale drawing for a customer's inspection, the chief object in view should be to get the drawing done as quickly as possible. Not only will "the iron be struck while it is hot," but the very fact that the inquiry has been followed up with the least possible delay will have a very good effect on the recipient. It is, therefore, essential, after the use of the drawing pen has been mastered, to perfect oneself in quick and clean production, rather than an elaborate or detailed piece of work, which may not only take double the time to execute, but often by its complexities harass rather than help the would-be client.

Speed can only be obtained by constant practice. In making the pencil outline, form the habit of putting the line in the right place the first time, and at one operation, a rule not only applying to straight lines, but to the freehand ones as well. This latter suggestion may surprise some draughtsmen who think it impossible to draw a curve perfectly at the first venture; but if the matter is thought over with any care, it will be seen that if one's mind is fully made up as to where the line is to go, it will, after sufficient practice and, consequently, control of that particular ability, take its proper course at the first time of asking. Our handwriting is, after all, only a question of freehand, and we are afraid it must be admitted that the shaping of the letters is an indication of how much thought is expended on their

formation, a conclusion which leads us to think that most writers pay more attention to the language rather than the caligraphy.

The quickest way to execute a side-elevation scale drawing in ink outline is, after pencilling in, to ink in the wheels first, adding the spokes if necessary, but it is now generally accepted that spokes are only necessary in a highly-finished coloured drawing. Most French houses, and one leading London motor coach-builder, have *all* drawings, whether coloured or in ink, prepared without the spokes, but in the opinion of the Author, a drawing has a better appearance if the spokes are inserted. The wheels completed, draw in all horizontal lines, working from top to bottom, and drawing in the line with one stroke of the pen. Then turn the board round and draw in all the vertical lines, working downwards as before. Then the other straight lines may be lined in with the tee-square still retained in the hand, but turned over. The hardest part of the task is now before the draughtsman. The success wherewith the curved lines are inked in will not depend entirely on the wooden curves or templates possessed. Given unlimited time, one can, of course, make special curves to suit the job in hand, or spend a long time choosing a suitable pattern. But when celerity is the incentive, a draughtsman, who should by constant use know exactly what his patterns will do, will bother himself with the least possible quantity, and will know exactly which pattern he wants at once, and, before putting it down again, draw in all the various lines it will help him to draw. In this way no pattern will be picked up twice, in the same way as the tee-square does all its work straight away. The curves having been finished with, the brush (a designer's sable), in skilful hands, will join up little corners, run in dub ends, and generally complete any small missing detail. When estimating for a motor body, it is always best to place the suggested design which accompanies it on the actual chassis required, from information taken from a blue print authenticated by the agent or manufacturer. But it may not be policy to make too extended an inquiry.

A side-elevation is generally sufficient, and is more perhaps in accordance with ideas of engineering, although a perspective drawing creates a better impression on a lady client, or any one who may not be practical enough to appreciate what is not shown in a side elevation—a representation which is a mechanical one, and, to an extent, misleading. The motor trade has been the cause of a great increase of outline scale drawings from the carriage builders. Draughtsmen should always take a duplicate tracing of all drawings sent out, quickness in tracing being effected on the same lines as in the original. Questions will often arise, when the original is retained by the client, as to certain measurements or style of outline, and a tracing will often prevent a great deal of misunderstanding and anxiety, also the draughtsman will require a guide of some sort before preparing the working drawing.

The quick draughtsman will appreciate a good quality smooth paper, as already stated, which will offer the least resistance to his pencil and pen.

Cardboard has advantages which are justified when expenses allow, and the tools, especially the brushes, should be of the best.

Whether the vehicle is to be horse-drawn or motor driven, it must be fitted for the intended purpose, having the qualities of strength, durability, style, proportion and finish, and other details subservient if the above points are to be successfully accomplished. The following considerations must be your guide in designing motor bodies : 1st. Type of chassis, H.P. (horse-power), and general purposes. 2nd. Length and width of chassis frame, position of steering wheel, change speed and brake levers, and foot pedals—together with the wheelbase, position of hind wheels and track. 3rd. Height of body, and the number of passengers. 4th. Form of chassis frame, rise of back, contracted back and front, dropped centre, position, and mode of support of petrol tank ; but it should be noted that whatever its shape, the body should be fitted for suitable steps for easy access.

These dimensions are got from chassis itself, or, from the engineer's drawing or print. As a rule, all parts in a motor body are larger than similar parts of horse-drawn carriages. A landau door is generally about 23 or 24 in. wide, but in a motor body door sometimes 30 in. or at times decreased to 18 in. or 20 in. in width, the size, shape and position of the doors and access to the body being dependent, to a large extent, on the length of chassis, and position. In this country, drawings are made to the scale of 1 in. to the foot (that is, one-twelfth of the full size), or $1\frac{1}{2}$ in. to the foot (that is $\frac{1}{8}$th of the full size). Other scales may be used, but the most common and useful is the *full size* drawing.

On the Continent the metric system is used, and as the coachbuilders of this country are continually building bodies to foreign-made drawings, therefore, a knowledge of this system is most essential. (*See* App. A.) In making a scale or full drawing of a motor body we have to remember the unerring principle of the square line, and proceed as follows :—

(1) Draw in the square line.
(2) Draw and square with it the line of the dash-board.
(3) On this mark the bottom of the body ; that is the height from the ground (on the motor to the top line of chassis).
(4) Parallel to (3) draw your elbow line ; that is the depth of door.
(5) Parallel to the bottom of body, mark the height of your hind seat from floor — (say 11 in., a suitable height) draw a line to the right.
(6) Above this, mark your head room, say 3 ft. 7 in., but never less than 3 ft. 6 in., and draw a line.
(7) Parallel to (2) draw a line to represent your door in width.
(8) Parallel to (1) draw a line to represent the boot side.

Apart from the general considerations already given for the making of working drawings, etc., we have other important details in the designing

of motor bodies, particularly the seating accommodation. Taking the back seat as the most important, it is safe to say that anything less than 3 ft. 4 in., measuring at the widest part of the seat inside of framing, will be close for two persons, and the minimum for three on the rear seat should be 4 ft. 3 in. As to the front seat, allow 3 ft. 3 in. inside, but in this seat we have much to consider, we have probably a centre division, and are restricted by the width across the standing pillars. We have also the front doors, the position of the levers, whether inside or outside, and the size and shape of dash. While the length of body depends on the number of the seats inside, and the length of chassis frame, any undue overhang behind the hind axle must be avoided. Make the distance from front seat to dash 24 in. to 28 in., but dependent on the angle of the steering wheel; that is, let the bottom lower edge of steering wheel fall in a line with the front edge of seat. Make the depth of driving seat from back to front 18 to 21 in., while the main back seat should have not less than 20 in., *far better* 22 or 23 in., clear seating depth, with a minimum distance of leg room in depth of 14 in. In bodies to carry four or five persons at the back, having two folding seats, behind the driver, it is as well to allow 31 in., with a seat to fold 15 in. wide, as 14 in. would be uncomfortable for long distance riding. These measurements are of course increased in proportion to the various requirements of chassis frame and type of body, but any decrease should be avoided, as leading to uncomfortable riding. It should be understood that the total width of body across the elbow line or waist rail is decided in a like manner, but it is unwise to have a greater width than the track of wheels at this part on the score of stability. In regard to height of seats from floor to top, this is to some extent dependent on the design of body, but the hind seat is rarely kept lower than 8 or 10 in., or higher than 14 in.; the same applies to the front seat, but in modern torpedoes, etc., the seat is as low as from 4 to 9 in. with a deep wedge cushion, while in some the steering lies at a very acute angle, but in fixing the depth of the front seat it is as well to allow at least 8 in. between lower edge of steering wheel and the top of cushion; thus if this point is 26 in. from bottom, and we have a 6 in. cushion, the top of seat would be 12 in. from bottom of body.

In open cars with a quarter panel, Phaeton type, endeavour to arrange the seat moulding so that the line of wing as it goes some 6 or 8 in. above the wheel does not break the line of body, for though the seat body line moulding frequently denotes the seat, the seat rail inside can really be fitted in any desired position and height, as in the case of full quarter flush-sided bodies. The modern type of body is on the continuous sweep, not as in the past, narrowed into the back of front seat, while the modern steam cars have bodies tapering gradually from the back part to the front of dash. At the same time bodies are kept shallow, but of greater total length, giving increased leg room, keeping as near as possible an uniform depth from back to front in order to reduce the windage and air resistance. In the

bottom of bodies all boards should be fitted loose, and any step-over piece avoided. In regard to the width of doors, 22 in. to 24 in. are common, and at times 27 in., but front and back doors are more often made too narrow than too wide. An 18 in. door is, or should be, a minimum in front, the hollow dash giving the required leg room, etc.

All seats should be pitched, the front as much as possible, the back seat from 3 to 4 in. or more and should be framed, not solid or boarded but "welled."

In well-made bodies an additional cane seat is sometimes added.

Head-room in bodies with a top is always (meaning from top of seat board under the cant rail): 3 ft. to 3 ft. 10 in., plus the thickness of cant rail, say 1½ in., and the approximate sweep of 1¾ to 2½ in.:—sweep of top transversely; this may be slightly increased, as it is in case of folding hoods. In folding hoods, such as Cape and Victoria, we measure under the centre hoop stick, giving a longitudinal sweep or drop of approximately 5½ to 6½ in. In the dimensions of seat panels (for touring bodies from top of seat boards to top of rail) many builders make a practice of giving a difference of 2 in.; thus we make the front seat 1 ft. 9 in. and the back 1 ft. 11 in.

CHAPTER VI

TIMBER USED FOR MOTOR BODIES

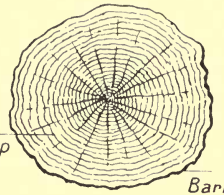
English.—Oak, ash, elm, beech, sycamore, willow, lime, etc., and other occasionally local grown wood. Timber is the product of a *felled* tree removed of its outer covering of bark. It should be felled (or cut down) in mid-winter. Vegetation is at a rest, the sap is all down, therefore we are likely to get in the process of *seasoning* timber with the fewest possible *shakes*.

Seasoning.—After cutting down comes the process of seasoning, that of drying out or expelling all moisture, the natural juices of the tree, necessary in life; but if not dried off properly, when cut down on the cessation of the growth, the wood is liable to decay, split and rot. This process of seasoning is done both naturally and artificially. Seasoning of timber renders it harder, stronger, more easily worked, more durable and less liable to twist. *Natural* seasoning is the best for English hard woods; the tree is cut into planks the required thickness, stacked in a dry and airy place, with dividing sticks regularly placed between each plank, allowing of uniform process of seasoning in the vacant places, by which the moisture is gradually dried out. The time required varies with the kind of wood and thickness of planks. Thus ash or elm planks, 6 in. thick, require about five years, oak about eight years. Generally speaking, after the first year for every inch allow one year. By this it will be seen that seasoned timber is expensive, because of the interest on the capital outlay. Artificial seasoning, as a rule, renders timber more brittle and less durable, and the process is rarely resorted to for wood required for motor work, except in the case of emergency. The methods adopted are *steaming* and *hot air*, and, if necessary, water. During the seasoning the timber is continually shrinking, due to the contraction of the capillary tubes which form the wood fibre, as the sap dries out. It does not shrink in its length, but principally in a direction perpendicular to it.

This unequal contraction gives rise to shakes and also bending or warping (Plate II.), change of form and dimensions. Each piece of framing should be bone dry, as, if *green*, it will not remain serviceable for long. If green wood is painted, trouble will soon follow. Evaporation from the pores is stopped, moisture is retarded, so that rot and decay soon set in.

Marking Out.—In the marking out of framing there should be "*no*" waste. The patterns should be laid to the grain, working one within another

2



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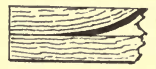

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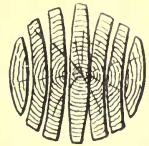

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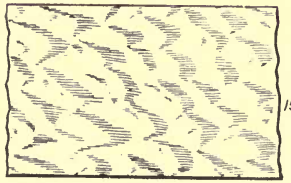

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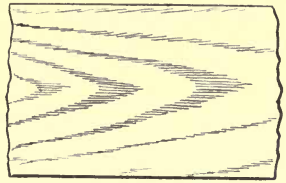
Figured on Wainscot Oak



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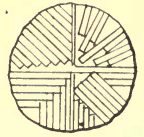
Plain Oak or Ash



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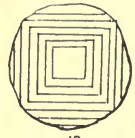

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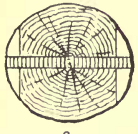

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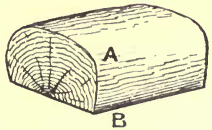

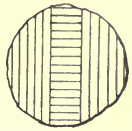

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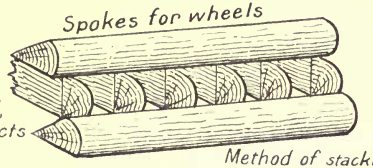
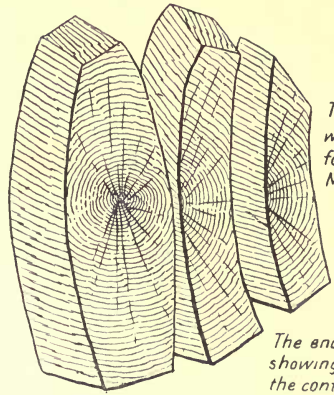
Spokes for wheels



Method of stacking Oak Saplings in tiers transversely to dry



Sketches 15, 16,
The conversion of timber when figured stuff is required for finishing the interior of Motor Bodies in polished wood.

The end section of a series of Planks showing the tendency to bend, the contraction of the fibres has curved the planks

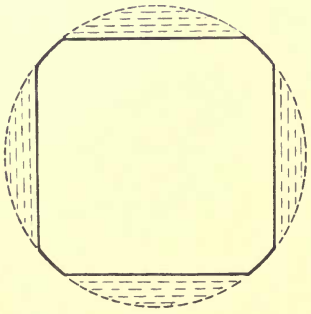
The sketches 1, 2, 3, 4, 5, 6, 7, illustrate the many defects found in timber parts.

where possible, allowing for the *saw* margin, then marked with a *race*, and cut out with band saw; and then, if possible, they should be further seasoned. At any rate, bars, rails, etc., may be always kept racked for use. All woods have a tendency to bend from the heart, so that in marking out door and standing pillars, take note that the door pillars should have the heart on the *outside* and the standing pillars on the *inside*, otherwise sooner or later there is trouble with the doors, which is never cured during the whole life of the body. The bodymaker cannot attach too much importance to utilizing his timber to the best advantage (Plate II).

Bent Timber.—Timber is bent for the purpose of economy, lightness and durability. The woods generally employed are English and American ash, birch, elm, hickory and lancewood. Uses in motor bodies are for bent top rails and sometimes elbow pieces, round corner pieces and rails, canopy and extension corner pieces. The bending process consists in merely steaming the wood after it has been wrought to its given size, and then by the aid of cramps and blocks forcing it into the shape of the patterns required, and firmly holding therein by blocks, cords and stretchers until the wood is set and dry. All bent timber is somewhat weak, and if any strain comes on it, it should be plated or otherwise strengthened.

Market Forms.—Timber is sold by the *load*, cube and superficial foot, it being priced *per inch*, though some fancy wood is sold by weight. In measuring the timber in the round, take the length or height of tree, then take the girth, or the circumference in the centre, with string, then *quarter* it by dividing by 4. The result squared will give the solid contents of the tree or log. If a large tapered tree, take the girth in three places, add together, divide by 3, with result proceed as before squared the length. The outside slabs are not always taken into consideration in squared up timber.

How to Ascertain the Entire Cubical and also the Usable Contents of Timber.

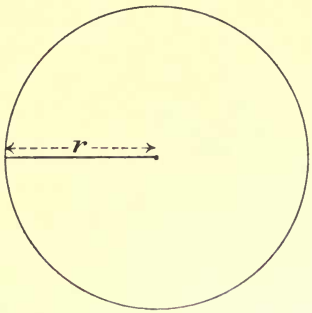


Rule I.—If the log should be tapered, take a string measurement of the girth in three places, and divide by 3: this will give the average circumference (if it is a regular taper the above will equal the centre circumference). If the diameters should be given, add them together and divide by 3, = average diameter, × by 3·14 = average circumference. Divide by 4, so as to square the log, as per Sketch 1, then square one side and multiply by the length. (All calculations to be done in inches, result cubic inches, divide same by 1,728 = cubic feet.)

This rule is used by the workmen, so as to ascertain approximately the wood that is usable; this method is also advantageous to the purchaser.

To find the Solidity of the Log, the Mathematical Formula must be used.

Rule II.—Find the average *diameter*, then: $v = r^2\pi b$. That is, volume = the radius squared, × by 3·14 (Greek symbol, π) × by the length.



The ratio between these two rules is approximately $\frac{3}{4}$, therefore Rule I allows about 25 per cent. of waste, which includes the bark, etc., as shown by the dotted lines of above sketch.

Tabulated List of Timber.—*English ash* for framework of bodies, pillars, rails, etc. *English oak* for bars, bottoms, sides, spokes, glass-frames, etc. English elm for step and landing boards, hubs of wheels, etc. *Beech* at times for framing bars, rails and felloes, etc. Willow, lime, and other similar woods are used as substitutes; but taking into consideration that English ash is a strong flexible wood, easily worked, bends readily, clean and takes paint well, besides withstanding when well seasoned the atmospheric changes of this climate, and up to the present time for price, weight for weight, it has no equal for body timbers.

Foreign Timbers.—*Mahogany.* There are two principal kinds, the Honduras mahogany or baywood and that from Cuba known as Spanish mahogany. Mahogany is strong in all directions, very durable, preserves its shape under trying conditions of heat and moisture. The Honduras is lighter in weight than Spanish. A good deal of bay mahogany comes from Mexico. It grows to a great width, bends readily, canvasses well, giving a good surface. Its principal use is for panels. The Spanish, taking a high polish, is largely used for frames, screens and interior cabinet work. By some builders in the North, mahogany is successfully used for standing pillars. African mahogany has a rougher grain, and is very little used except for frames and fittings. *Cedar*, as a substitute for mahogany, is more open, porous, does not paint well, bends readily, and is chiefly used for corner panels. *Teak* is by some builders extensively used for the framework of bodies to be exported, possesses great strength and durability, and contains an aromatic oil which acts as a preservative. *Pine* is a soft elastic wood; there are many varieties, but the best known is the yellow and Weymouth pine, which is imported from the Baltic ports and is used for boarding and lining up. *Whitewood*, an American wood, is used in large quantities for cheap work and frequently in places for which it is not suitable. Whitewoods differ extremely in

quality, the very greenish in colour is not desirable, as it is liable to buckle, is porous, and does not paint well; it is most useful for step boards, running boards, and boot sides, but if not carefully worked in bolting and screwing is liable to split. *American ash* is used largely in motor work, and resembles English, though lighter in nature and quality. A large number of fancy woods are used for decorative work and interior fittings, such as *sycamore, birdseye maple, satin-walnut, satin-wood, ebony, boxwood*, etc. Some very fancy woods are sold by the weight. A custom of the trade is to sell everything above 1 in. in thickness at per foot super. Round logs, particularly some grain timber, are sold by the string measure, that is, taking the girth round the trunk, as already described. Most mahogany logs are bought and sold under what is called the "*Liverpool Measure*" at per foot super of inch. This is advantageous from the buyer's point of view. It should be understood that trade and actual sizes of timber, both width and thickness, differ in some cases greatly, owing to the amount of wood used in sawing and planing. Most coachmakers' timber is bought and sold by the load, which weighs one ton and may be any of the following :—

40	cube	ft.	of	round	timber, or
50	,,	,,		squared,	
600	super	ft.	of	1	in. plank.
400	,,	,,		$1\frac{1}{2}$	,, ,,
300	,,	,,		2	,, ,,
240	,,	,,		$2\frac{1}{2}$	,, ,,
200	,,	,,		3	,, ,,
150	,,	,,		4	,, ,,
120	,,	,,		5	,, ,,
100	,,	,,		6	,, ,,

Timber is also measured by the following rules, which give the contents in feet of board measure :—

For	5	in.	timber	multiply	$\frac{5}{12}$	of the length by the width.	
,,	6	,,	,,	,,	$\frac{1}{2}$	,, ,,	,,
,,	7	,,	,,	,,	$\frac{7}{12}$	,, ,,	,,
,,	8	,,	Lumber,	,,	$\frac{2}{3}$	,, ,,	,,
,,	9	,,	,,	,,	$\frac{3}{4}$	,, ,,	,,
,,	10	,,	,,	,,	$\frac{5}{6}$	,, ,,	,,
,,	11	,,	,,	,,	$\frac{11}{12}$	,, ,,	,,
,,	12	,,	,,	,,	length.		

Seasoned wood can be told by the feel of the shavings, which are of a lustrous colour with a bright sheen. A dull colour, as a rule, denotes inferiority. If the colour is bright the darker the tint the better, with the exception of elm, in which the dark timber is inferior to heart and should not be used. Bars, rails, standing pillars and size stuff should be kept cut out and stacked, so that all liability to shrink in use is reduced; this is called *second seasoning.*

By the foregoing remarks the reader will note that the motor body builder has a long list of materials with which it is necessary he should be

more or less familiar, for not only does he build his house, but he has to furnish it as well, and modern tendencies, with their demand for luxury, do not in any way lessen the number of substances to consider. It has always been the primary consideration of the successful body-builder, the owner of the factory, where a reputation has been maintained, that the timber shall be of the finest quality, not only in product of sound trees, but the result of thorough seasoning, and consequently the evolution of body-work, the joints and panels of which shall always maintain their true relationship to the adjacent parts.

Commercial Names.—A tree has often a commercial name given to it quite apart from its botanical classification. The word "cedar" is applied in the case of West Indian timbers, which are only so in colour and smell, but really belong to the mahogany class in the general structure of the tree. It will also be readily understood that such terms as "red and white pine" have different meanings according to the district, and the term "yellow poplar" often given to the whitewood or tulip tree, leads one to believe it belongs to the "poplar" class, but it is not so. We should, in our study of foreign timber, not be too enthusiastic over the stereotyped brands of which we have a more or less extended experience, although there is always something fresh to learn even in this direction, but, on the other hand, we should be willing to learn and, if means allow, to experiment with new timbers which come under our notice from time to time. There are without doubt many foreign timbers of great service-ability yet little known. Most of the species which grow in the warm and tropical climes are dense and hard in character, and in their strength would no doubt be suitable for the motor body builder's use. There are also virgin forests of the softer woods in Australasia. In many cases, however, these forests of hardwood abound in districts where modern appliances for bringing the cut timber down to the shores and loading into the vessels are not yet available, living is in some cases unhealthy, and the natural conditions to be overcome would demand large operations to justify initial expenses. However, the time will come when these new districts will be attacked, for we hear little of any planting of the saplings of young timber trees, and already, as is mentioned later on, the supplies of Honduras mahogany are beginning to fail in the British colony itself, and we are not surprised to hear that those which were the most get-at-able trees are the ones which have been cut down.

Government Interest in Timber.—In an excellent little handbook before the writer, compiled officially on Tasmanian timbers, we have an instance of what might be done in other parts of the world to give timber merchants and consumers particulars of the comparatively unknown types and their properties with a view to their adoption. In the valuable pamphlet, the native timbers, some fifty in number, are fully described, and their weights and strengths are compared with well-known European timbers such

as ash, deal, and oak. The exact mode of carrying out the experiments with the Tasmanian woods is carefully described in detail, so that the result may be checked if necessary. As well as describing and giving the physical properties, the by-products, such as essential oils, fibres, honey, potash, tannin, and pulp, are mentioned, together with information as to prices, rainfall, sawmill leases, and water rights. Photographs are reproduced of the timbers when fractured and the process of felling. It also states that a similar exhaustive treatise has been prepared on the neighbouring Australian timbers, as well as on those of Jamaica.

Difficulty of Identification.—A paragraph worth quoting in this book is the following :—" The identification and differentiation of timbers, if not absolutely impossible, requires a lifelong acquaintance with the subject. Each name may be said to cover several closely allied varieties rather than one specific kind. The bushman and the man who lives amongst timber would scout the idea of " gum-topped stringy bark " (a tall tree useful to carpenters and joiners) being called a " peppermint," but peppermint is a division to which this tree comes nearest botanically. Then trees acknowledged to be exactly the same kind, will produce very different timbers, according to where they grow. For instance, upon a rocky eminence or in a sheltered river bottom, the timber will differ in texture, in colour, in durability, and in weight according to the soil and situation."

To sum up, the trunk separated from its leaves, fruit and flowers, is difficult even for an expert to label with botanical exactness.

Local Drawbacks.—From the *Notes upon the Island of Dominica* (a West Indian island) by Symington Grieve, we gather that many kinds of valuable trees grow throughout the island, and reach a great size. At present trees cannot be removed to any great distance to the sawmill which has been put in operation by the Government. The writer points out that the logs were cut up comparatively green, to the detriment of the planks and boards. Of great interest is the fact that many kinds of timber grow in the island, but no great number of any one kind of timber grow together. This, of course, proves a drawback, as any one starting a sawmill would only be able to contract to supply small quantities, and even then at uncertain intervals. So here we see some of the conditions which work together to make mahogany and other timbers growing in this district dear. Curiously, a larger quantity of timber is imported than exported, a fair proportion of the former being pine.

I propose to confine myself for the present to the interesting details relating to those woods brought from abroad which contribute mainly to the structure of bodies of all descriptions after the framing has been dealt with.

Shipping Timber.—Timber is considered by the shipper as a bulk cargo, and one which requires a lot of space for handling below deck. In later patterns of cargo vessels, the tendency has been to increase the depth of the hold, and whereas 15 ft. was considered a maximum some fifteen years

ago, ships are now constructed where the vertical depth of pure single deckers has been increased to 28 ft., and such are now fairly common. The greater part of the timber exported to this country from the areas mentioned finds its way to Liverpool and London, where the prices realized at the auction sales held are looked upon as showing the tendency of the market. In shipping timber from foreign countries, it is the most economical method to have it cut up into boards and planks, all unusable portions being trimmed off, and the edges squared, in the country of its growth, and as near the forest as possible. Not only is money saved and the timber made cheaper, but it can be carried to the hold of the ship with less waste of room. Consider the round edge logs lying side by side under the hatches of the cargo boat, and at once it is realized that much space is unavoidable between the logs, and the importer is paying freightage for carrying bark, sapwood, and other portions which are usually cast aside. If the tree is cut up into strictly sound pieces of timber, and these are themselves squared up, it follows that this essential portion of the wood, by reason of its shape, can be tightly packed into the hold, and every nook and cranny is occupied with valuable wood, every inch of it justifying the cost of carriage. But there are others who prefer to see the timber enhanced in price by being brought over simply as cut down, or the logs just squared up, as they say they would prefer to see the money spent here in utilizing our own sawmills to convert the stuff into commercial shape. The buyer of timber who goes to the States to purchase for his firm has a difficult task before him in order to effect a good deal. The American "miller" cuts up such an enormous quantity of trees for local use, that he often treats with scant courtesy the demands for "three h'aporth" on the part of the British buyer. There is a close rivalry between London and Liverpool as to which is the greater foreign timber port. Merchants divide their attentions pretty equally between the two great cities, and, if anything, the metropolis has a slight advantage.

It may be of interest to the reader if I were to give fuller details on a few of the timbers which have been already mentioned at the beginning of the chapter.

Mahogany.—This is the most expensive timber used to any extent by the body-maker, and, consequently, great care is taken of the panel boards in the timber loft; in fact, many prefer to keep this part of the timber stock under lock and key. The price of mahogany panelling is, partly, the result of the bad commercial conditions under which the trees are felled and brought down to the port of export, but scarcity has enhanced the price of late. The trees grow in many districts known as Central America, and some of the most important forests worked are, happily, in our possession in this part of the world—that of British Honduras, where logs are exported to the value of £120,000 annually. We find that varying quantities and qualities are felled for export in Nicaragua, Costa Rica, and

Panama, but the natives are lazy, personal property is not always safe, and the general state of affairs, owing to political conditions, is not always favourable to extended business enterprise. Moreover, the ports have indifferent harbours, especially on the more important eastern or Atlantic coast, and not until railways are more numerous, and other means of communication improved, will there be any real chance of proving as to whether other forests are available. In British Honduras, we have a territory about the size of Wales, with a population of nearly 40,000, most of whom are descendants of negroes and Indian slaves from the West Indies. The best trees are cut on the higher ground inland ; those from the low and swampy coasts of this and other mahogany-bearing districts in the West Indies are much inferior. The stately and beautiful tree, with its buttressed trunk and leaves very much like our English ash, supplies rude furniture for the black and brown natives. The timber is transported from the logging camps on strong trucks drawn by bullock teams, very much after the style of our own timber carriages, the vehicle being adjustable as to its length and running on disc wheels, a model of which may be seen in one of the museums at Kew Gardens. Sometimes sledges are used. It is then formed into rafts and floated down into the large streams, and drifted out with the tide to the vessels, which have to lie well out, as the coast is fringed with dangerous shoals.

Naturally we should expect to find the mahogany tree growing in the adjacent countries on the mainland, and this natural inference is borne out in finding large quantities in Mexico, at one end of Central America, while at the other we find Columbia and Venezuela contributing, but in smaller quantities, yet the quality is not by any means the same. Then again, the West Indies lie comparatively near, and in the same latitudes as Central America, and here we find Cuba and Hayti among the larger islands, and St. Lucia, and some of the Bahamas, among the smaller, deriving much of their prosperity from the presence of this valuable commodity. The supply from Jamaica has fallen off during the last few years. Roughly speaking, the land lying between the Tropic of Cancer and 5 ° N. of the Equator, is favourable to the cultivation of this tree, and on following this belt across the face of the globe, we find varieties of this timber growing in the districts of the Sudan, Guinea Coast, and Gold Coast, where the natural conditions allow, the Africa type of mahogany being now of no little importance. In India another variety is found, and also in the East Indies. The true mahoganies, however, may be considered as confined to tropical America and the West Indies.

Varieties according to District.—Our chief supply of best panel-board comes from British Honduras, and is sometimes known as bay-wood, although the most accessible forests have been well-worked, and if good timber is to be found, new districts will shortly have to be opened up. Inferior and larger trees come from Mexico and the other Central American

districts already mentioned. When felled it is of a light reddish brown colour, which, however, soon darkens on exposure to the air. The grain is close and straight, and may be reckoned as a hard wood, whilst the normal qualities are free from shakes, and not liable to warp. Inferior qualities are apt to be brittle on drying, and to develop star shakes. Honduras is a term which in the genuine brands of timber has gained an enviable reputation, signifying a high grade of mahogany suitable for general purposes. This, however, has led to rather an elastic use of the term, and it is not unknown for timber grown in Guatemala (a district to the west and south of British Honduras), and Mexico, around the Gulf of Campecchy, to be labelled as if native to the British Crown Colony. The Mexican timber is generally softer, and comes to market in logs from 18 ft. to 30 ft. long, and from 15 in. to 48 in. square.

Spanish Mahogany.—The finest mahogany is that grown in the islands of Cuba and St. Domingo, known as Spanish, a term which only suggests the past history of these islands. The magnificent trees of these Greater Antilles have an unrivalled name for richness and beauty among all wood-workers. It is a timber of a deep rich brown, and in its figured logs, demands high price for decorative work and furniture, in fact the price depends on the character and beauty of the figure. It is harder and more curly in the grain than the Honduras variety. It is said that Sir Walter Raleigh discovered this tree during his expedition to the " Spanish Main " in 1595, but its introduction cannot be traced until 1720 by Gibbons, when it was brought home as ballast in a ship, and at first regarded with disfavour, owing to its hardness. The Spanish variety differs from the variety grown on the mainland in having the pores generally choked with a white chalky substance. The name " mahogany " is taken from the native word " mahogani."

In buying timber, it is well to remember that trees grown in swampy districts will often show grey specks and patches, technically known as " black bottom," which, if unregarded, may develop into dry rot, so should be rigidly discarded. The tree grows to a height of 50 ft., sound logs being obtainable up to 40 ft. long and 30 in. square, and occasionally of larger dimensions. The attacks of grubs or worms should be carefully looked for, a defect to which this timber is liable. A cubic foot of Honduras mahogany weighs from 35 lb. to 40 lb., while the Spanish variety averages about 50 lb. per cubic foot, but the former variety has greater strength, stiffness, and resilience, these properties being almost on a level with that of white pine. Mahogany also gets brittle with age. The trees grow in many cases to a height of from 80 ft. to 100 ft., and the timber is sound throughout, even the largest trees. A fine Spanish log will sometimes fetch as much as £1,000 when purchased for veneering purposes. The annual imports into Great Britain are about 40,000 tons, valued at £350,000. The bark has febrifugal properties, being used locally to counteract the effects of fever.

Although the specific gravity of timbers varies considerably, yet the density of the sawdust is practically the same in all woods, showing that the enclosed air is an important factor in deciding the weight of a bar of timber.

Cedar.—This aromatic timber is closely allied to mahogany in appearance—in fact, some of the varieties are liable to be mistaken for mahogany. The confusion of mahogany with cedar is explained at least in one instance where the same districts, such as the West Indies and tropical America, produce a " cedar tree " which is familiar to many in the form of cigar boxes. Botanically, this is really in the same class as mahogany. The Levantine cedar is found in Asia Minor, Cyprus, and the Atlas Mountains in Algeria —in fact, it is sometimes known as the Atlas cedar. Closely allied to the cedars found in the Levant are the deodars of the Himalayas which are the principal timber trees of Northern India, and find many uses without being exported. The cedar of Lebanon, of Biblical fame, is, with the Atlas cedar and the Deodar, classed together by botanists under the name of *Cedras Libani.*

In Australia the *Cedrela Australis* found in New South Wales and Queensland is, especially in the former instance, highly esteemed as a panel wood for carriage and motor body building, and considered by some equal to mahogany, but it only resembles cedar in smell, and is a close-grained wood and heavy. The true cedar of the Levant is a large tree, sometimes over 4 ft. in diameter. It is rather loose and porous, often soft as pine and has a particular aroma. The deodar is very durable and is yellow to light brown in colour. The East Indian and Australian cedars resemble mahogany in colour and grain, while a red cedar is found also in North America resembling very much the true cedar. The West Indian is a smaller tree. Seeing, therefore, that this timber is found on all continents except Europe, and that many are very similar in appearance when cut up, it takes a great deal of experience to be able to recognize from mere outward appearance the nationality of the tree from the log or cut timber. The general aspect of the cedar is noble and imposing when the tree is fully grown. This effect is, no doubt, caused by the propensity the larger branches have of spreading themselves horizontally, so that the tree has often greater width than height. The spiky clusters of leaves, which generally run about an inch long and arrange themselves in clusters together with the cones, proclaim the relationship of the cedars to the conifers, a family to which the pines and firs belong. The cones do not drop as a whole from the branches, as in other conifers, but have the peculiarity of shedding themselves in scales along with the seeds, the axis of the cone being left attached to the upper side of the branch. It is said that unprotected cedar wood has a harmful effect on printing ink, so that it is not a safe material of which to construct cabinet work for interior body-work. The cedar, under favourable conditions, attains to a great age, one or two of the patriarchal cedars of Lebanon being, it is said, nearly 1,000 years old,

but fifty to sixty years is the age of the usual commercial variety. The cedar of Lebanon weighs 31 lb. to the cubic foot, while the American variety is slightly heavier. The West Indian tree in the best varieties runs as high as 47 lb. to 50 lb. to the cubic foot, being sometimes denser than the best Honduras mahogany, but not quite up to the specific gravity of the Spanish variety. Compared with other woods, it has little strength, and has very little stiffness, being quite unsuited for framing where strains are likely to take place. Its great property, however, is its bending power for quick arch panels.

Cedar Panels.—The carriage builder's cedar comes from the West Indies, chiefly Honduras, Tobasco, and Cuba, and there has been a very steady supply from these districts for some twenty-five years. I have met members of the trade who have quite seriously thought that their cheaper panel wood came from the land of more famous cedars, but the mistake is easily made, for on taking up any standard encyclopædia or general work on Timber, it will be found that the greater importance is given to the cedars of Lebanon, the deodar, and those growing in Syria and Northern Africa. Some builders will not use cedar at all, but there are many who consider it desirable for quick bends. Pencil cedar, such as is used for enclosing the plumbago of our pencils, is a soft and very faulty wood, quite unsuited for any serious constructional purposes.

Whitewood.—This timber is imported from the United States, a large quantity passing annually through New York. It is used by the motor body builder for most of those parts to which pine is applicable—in fact, in some instances almost to its exclusion. Being a large and straight tree, it yields very wide boards, and it is easy, as a rule, to obtain clean straight grained stuff 40 in. wide. It is also known as tulipwood, a name which is taken from its greenish-yellow flower. Although usually called whitewood, it is sometimes called yellow poplar or canary wood, in reference to the tone of wood approaching to a lemon colour, which the best varieties show on being cut. The lighter cut are considered inferior. The term "saddle tree" is, no doubt, a reference to the peculiar somewhat saddle-shaped leaves. The trunk attains a height of from 70 ft. to 100 ft., and instances have been known of the tulip tree rising to a height of 140 ft., while the diameter varies from 18 in. to a few examples measuring some 7 ft. through. The timber, though classed among the light woods, is heavier than common poplar, though it does not exceed many of the pines in density. It is easily worked, and takes polish well, forming thereby a good basis for imitation articles to be finished as mahogany or walnut. It is, however, liable to buckle to a great extent if exposed to alternate dryness and moisture, especially if used in wide pieces. The heart wood of the tulip tree approaches a yellow colour, while the sapwood or alburnum is white. The timber sometimes reaches this country in the form of waney logs—that is, imperfectly squared, having the corners rounded or flattened, sometimes with

the bark showing—a form in which much foreign timber arrives. Whitewood is not so strong as pine, taking it all round, as it lacks rigidity. It is used for floor, lining and roof boards, and solid rocker or boot-sides where the strains are not complicated. The framed rocker side of ash panelled with mahogany is, on the face of it, a far stronger piece of construction, as both these woods have double the strength and stiffness, especially the former; still, the factor of cheapness, both in labour and material, decides the use of the solid side in the construction of many bodies, even by the best houses. There are many varieties, as well as names, of whitewood, and the timber merchant himself is often perplexed. It is not a lasting reliable wood, and it is not desirable to use it for floorboards, especially in motor work, which are generally loose and exposed to the weather on the underside, only being protected in many cases by a single coat of paint put on indifferently by a boy. Pine is a far better wood to use here, and even birch, which is generally used for the long side steps, may be used with advantage for the movable floorboards, and it would be a good plan to batten them whatever the material used.

Birch.—The tree is sufficiently beautiful to have received the special attention of poets and artists, and is at the same time one of the hardiest trees known. It is found over a wide area in the Northern Hemisphere, is quite absent in the Southern Hemisphere, and is remarkable for the fact that it will grow farther north than any other tree. Its power to resist a low temperature is again shown by this species of tree flourishing at great heights. It is found in Greenland and Iceland, and in the extreme north of America, where its local usage has given it the name of canoe-birch. It grows best in the lighter soils, preferably of a sandy description, and the presence of the tree, especially in Russia, generally indicates land suitable for the plough or the growth of corn. The tree is widely distributed, being found, in closely allied varieties, throughout Europe, Russian Asia, and America, as already indicated. It will grow at greater altitudes even than the fir, and in exceptional instances has been found forming little woods at 6,000 ft. above the level of the sea. The birch with which we are familiar in Britain is the most abundant on mountainous or sandy soil. In the Highlands of Scotland it is used for building some of the local carts and ploughs, as well as for many domestic purposes. This tree, however, is seldom more than a foot in diameter, and is quite unsuited for the general purpose of motor body building. Canadian birch is the variety used for solid boot-sides and seat boards in motors and also the long side steps. This is a much larger tree, and is exported from the same district as Quebec pine. It is a tree of rapid growth, often rising to a height of 80 ft. with a 36 in. diameter. The logs may be obtained fairly straight up to 40 ft. The wood is straight grained, and sometimes well figured, which, when particularly so, is even cut into veneers. It is hard and tough, and will stand a considerable amount of wear and tear; in fact, it is the strongest timber used in the board

by the motor body builder. It is particularly suited to resisting damp, and its uses for floor boards is to be commended rather than pine, not only for this reason, but for the added advantage of its resistance to rough wear, it being almost as tough as elm. With all these resisting powers, although of a compact nature, it is easily worked. When newly cut, the surface has a rosy hue, which deepens, however, on exposure. It resembles mahogany sometimes in colour, hence perhaps the name of "mountain mahogany," but, being capable of taking a high polish, it has often been stained to imitate that wood. It arrives in this country from America in the same forms as whitewood, being often landed in ready-sawn squared-up boards and planks. The European birch strips its bark horizontally, making dark rings at irregular intervals on the trunk. These layers are cast off like fine tissue paper. The greater part of the bark being silvery white adds to the apparent slenderness of the tree, and makes it conspicuous at long distances. Birch belongs to the catkin-bearing group. It is the only tree found in Greenland. In comparing its physical properties it weighs about the same per cubic foot as English ash, namely 44 lb., and it is nearly as strong in some ways, but is inferior in resisting compression and shearing stresses, which at once shows its inferiority for under-carriage work of carriages, besides being liable to split. As the branches grow near the top of the bole, the timber is found free from knots.

CHAPTER VII

FRAMING

Cabriolet.—Before starting on the drawing of a Cabriolet body you must obtain full details of the chassis, as previously stated in the chapter on DESIGN OF MOTOR BODIES.

These bodies have a full deep quarter panel (*see* Plate XXI), no recesses are cut in the sides themselves after the completion of the body, the vacant spaces having metal panels neatly fitted. The process of making full size drawing must in this case, as in all others, be fully adhered to of the square line, horizontal and vertical lines placed so as to denote the various dimensions before the outline is drawn. After drawing the outline the mouldings are marked on and the cant board made up with the patterns. In drawing the cant we must settle the important dimensions of length on the hind seat rail. Having two persons on the hind seat in these bodies, 3 ft. 10 in. is given, that will give ample space—and the front seat 3 ft. 5 in.

The board is now made up, having the line of chassis drawn on it, and the points of the body are marked off in the following order :—

The length of frame, the position of the door, the length of hind-quarter on top, the square line of joint of hind corner pillar and bottom side, the width of front pillar at elbow, the length of front quarter and front door, the position of seat rail and hind bar, also the square line of front rail when it is to have a front drop light. The pillar pattern of the standing pillar which gives the amount of *turnunder* is made to provide for the run of glass frame with sufficient substance at the bottom to ensure good fixing for the door bottom.

Besides the runs there is the door rail and garnish rail, and from back to front we shall probably require $3\frac{1}{4}$ in. to $3\frac{1}{2}$ in., taking the thickness together with the inside grooving. Motor bodies with moderate amount of side sweep, but a large amount of turnunder, are common. Thus in a straight batten body we have a width over the elbows of 4 ft. 2 in., but a turnunder of $7\frac{3}{4}$ in. If the square lines of the elbow, seat rail, joint of corner pillar and bottom-side be marked on the pillar, after the side sweep is drawn on the cant board, there is no difficulty in finding their position. For instance, the chassis line is 35 in., the point of standing pillar square line will be 11 in. outside ; this will bring the body 4 ft. 9 in., at the corner pillar $7\frac{1}{2}$ in., which

gives a width of 4 ft. 2 in. At the front seat, 3 in., this will give a width of 3 ft. 5 in. inside the body, then the thickness of pillar must be marked to get full width, which probably will be $1\frac{1}{4}$ in., so that the full width across the body at this point will be 3 ft. $7\frac{1}{2}$ in., while outside front pillar tops of 48 in. over all our point will be $6\frac{1}{2}$ in. Passing through these several points is the sweep of the side of the body seen on the elbow line, then, as you move downwards from that line, every part becomes a quicker graduated sweep or curve. Some body-builders, however, keep to the same sweep, notwithstanding the turnunder, while others make a return sweep on the bottom, and foreign bodies frequently have two sweeps, using a flat one for the doors.

The distance at the standing pillar below the elbow line, the position of any line marking the starting-point of the curvature can always be taken by holding a straight edge on the pattern, then if at the seat line it shows 3 in. turnunder, this point will show 3 in. in your cant inside the side-sweep. In the same way with the bottom side, if the extreme turnunder is $7\frac{1}{2}$ in., this line will show that distance inside. Having found these points the sweeps will be fitted or drawn, then the various thicknesses of timber used for framing will be marked off because the lines already drawn are only the outside of the body framing. The object of the cant is to combine the outside with the inside, showing how each piece is connected with its fellowpiece of framing, together with the angle of the shoulders of joints.

CHAPTER VIII

DESIGNER'S QUALIFICATIONS—DRAUGHTING FOR BODYMAKERS

The qualifications of a skilled designer are *large* individual experience and constant practice. His work can be said to consist in the following qualifications :—

1st. He should be able to draw.

2nd. To be successful he must know all periods of style.

3rd. He must have a thorough knowledge of the nature and properties of the materials and the quality and manufactures of the fabrics used.

4th. He must endeavour to train and cultivate the imagination in order to produce what by courtesy may be termed original without being confined to any given style or period.

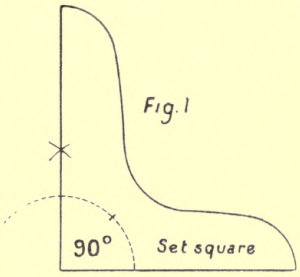
5th. He must work in sympathy with the requirements of the trade.

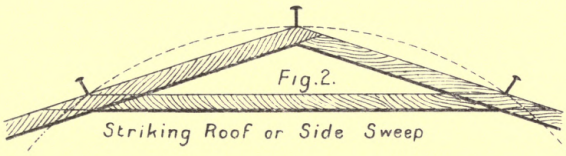
Draughting for Bodymakers.—The following are some very useful geometrical problems which it is necessary for every bodymaker to solve so as to carry on his work correctly. It is not the intention to go into the subject of geometry at any length, for it embodies detail, which, under working conditions, it is difficult to include or carry out, however right in theory they may be, but, on the other hand, it is necessary to understand the elementary principle to carry out your ideas faithfully. In making full-size drawing it is often necessary to make full-size sections, and frequently centres have to be found by development of plain or twisted surfaces. Freehand drawing is largely a question of temperament, but the principles of geometrical drawing can be acquired by any one who cares to make a study of the few simple directions given in the figures herewith given (Plate III). Scale drawings are resorted to to do away with the necessity of making every drawing full size. The 1½ scale is most useful, as most details can be shown. All working drawing (full size) should be on stout paper and in pencil. Blackboard with chalk is not a permanent reliable drawing unless done on black paper ; it then makes a very effective drawing and can be kept for reference. White chalk on brown paper is a poor substitute.

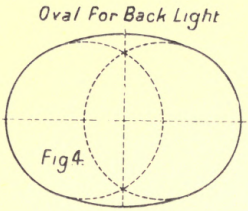
Fig. 1 is to make a square board and is a right angle of 90 degrees.

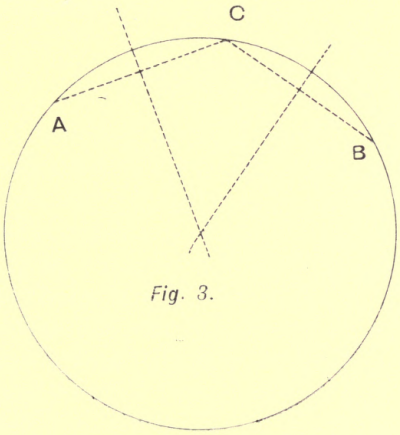
Fig. 2 is the method of striking out large sweeps, as the bodymakers side or roof sweeps, fixing together strips of wood to form a triangle to the

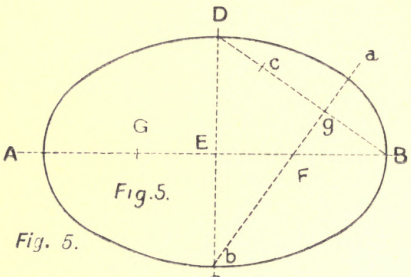
PLATE III.

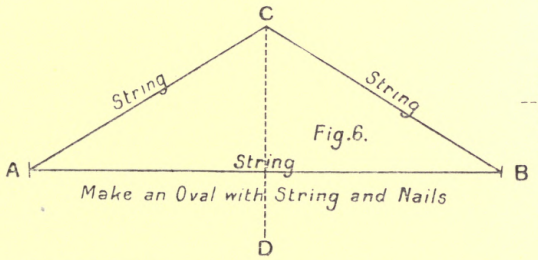


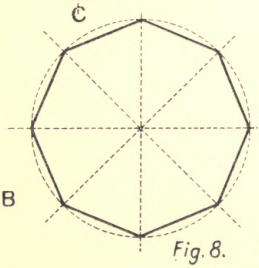












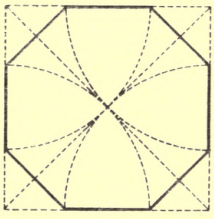
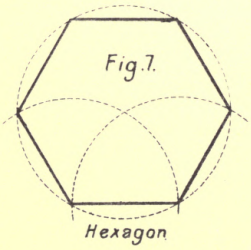


Fig. 9.
Octagon in a Square



length and length of sweeps and with pins inserted pass round, striking the line of sweep.

Fig. 3. To find the sweep or circle passing through three points A, B, C, join them and bisect the intersection of bisecting line, which gives the radius.

Fig. 4. A method of striking an oval by intersecting circles.

Figs. 5 and 6. Striking an oval by geometry and with compasses, A B, C D is the length and breadth, join B D, and make C D equal to the difference between D E and A E, halve B C; through the centre line draw a b, intersecting E B in F; F, G are the centres of the arcs forming the oval; the two lines of height and length cut one another at G. With C as centre, and G B, or G A as radius, strike off E, F on the long axis of the oval. Nails should be driven in perpendicularly at E, F, C, a piece of string stretched round the three points, remove nail at C, and allow the string to act as a guide for the point of pencil, which is moved in a circular direction. If this is carefully done the ellipse is made with great ease.

Fig. 7. A six-sided figure, by stepping out with radius.

Fig. 8. Octagon, by bisecting.

Fig. 9. The eight sides in a square with the radius of diagonal.

Fig. 11 (Plate IV) will enable a man at a job away from the shop to strike a circle without compasses; the diagram shows how, by fastening two strips of wood together square, to form a right angle; at the extremities A, C fix two pins, then by sliding the sides of the laths, keeping in contact with pins a pencil held at B, he will describe A, B, C—reverse to complete circle.

Figs. 12 and 20 show how curved lines may be plotted out; the plotting is done by a series of lines square with a given line and the distance stepped out. The various figures should all be first struck from a square line, the throw out, or the turnunder, set off and the curved line drawn in or stepped off. Accuracy and correct centring alone is necessary for precise and successful results

PLATE IV.

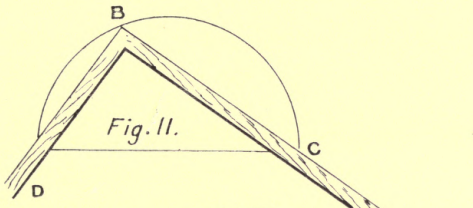


Fig. 11.

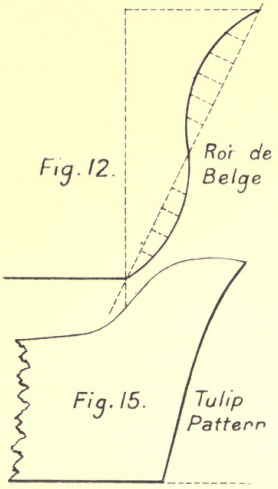


Fig. 12.

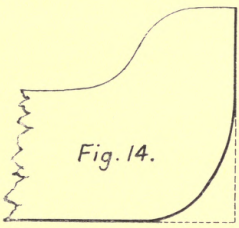


Fig. 14. Rotund

Fig. 15. Tulip Pattern

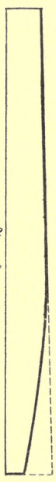


Fig. 16. Plain simple sweep Turnunder

Fig. 13.

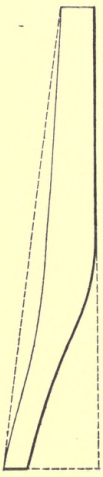


Fig. 17. Turnunder return sweep

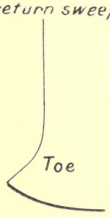


Fig. 20.

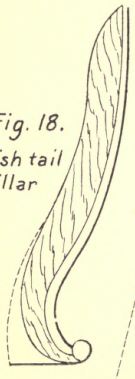


Fig. 18. Fish tail Pillar

Fig. 19

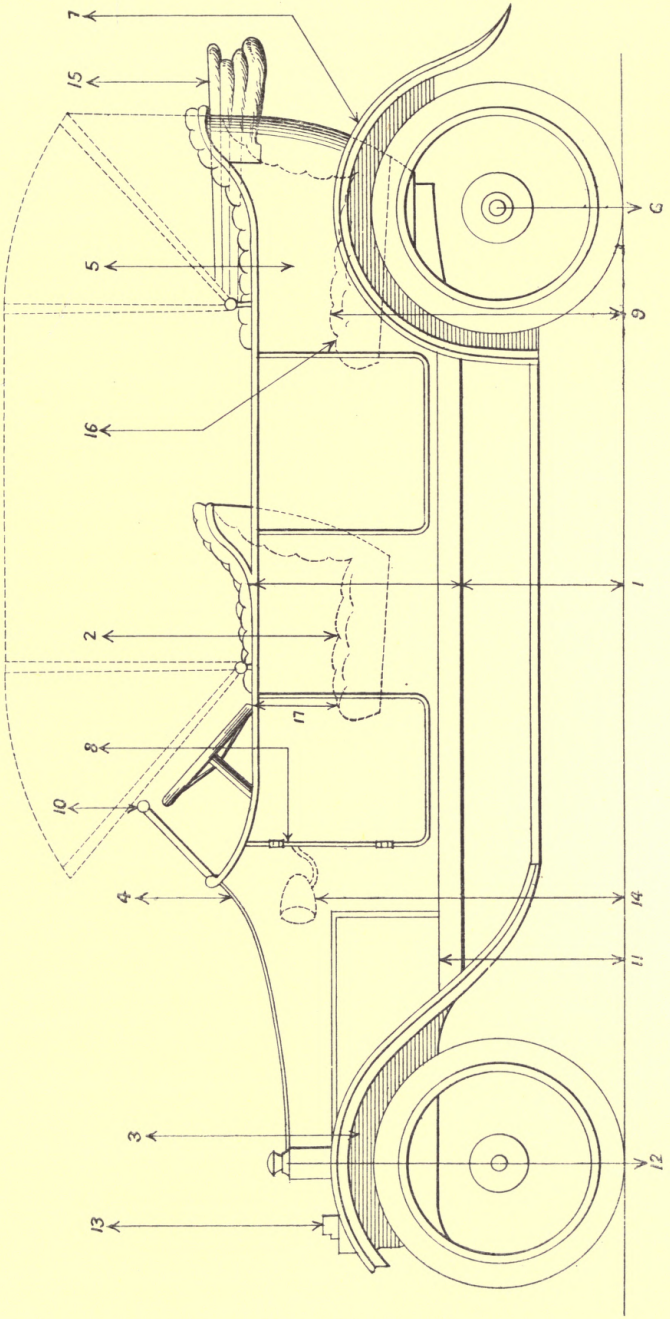
CHAPTER IX

CUSTOMERS' DRAWINGS—COLOURING AND TINTING DRAWINGS—ESSENTIAL QUALITIES OF GOOD DESIGN

The essential qualities of good design as to touring side-entrance bodies.—The great merits of the flush-sided bodies fitted with the scuttle dash and full size front wind doors are considerably marred if badly proportioned, and the full comfort of protection in bad weather and ease in riding to the occupants and the general appearance may be utterly destroyed if the general directions as to what is really necessary and reasonable in measurements are not thoroughly understood and followed. The sketches show, on the one hand, a body possessing many good points with an equal distribution of weight—its size and shape such that while giving comfort to the occupants it should offer the least amount of wind resistance in rapid travelling. Though the bodymaker is entirely governed by the size of chassis, it will be as well for him to work as near as possible to the points summarized at the latter parts of this chapter, in fact, a capable draughtsman will keep them in his mind continually.

A rule for guidance is to keep, so far as possible, an unbroken tapering line along the top of seat in a line with the bonnet and top of dash making the line of body, deciding its height approximately similar to the height of frame from ground. Thus we find frequently frame 24½ in., depth of sides 25 in. Total depth of scuttle dash 29 in. Total of body at rear seat 29½ in. or 30 in. But even this measurement for various cars can be worked on a graduated system. The average depth of the back seat squabs to be 21 in. above cushion, while the front of cushion should be at least 12 in. from top to bottom of body. Of course, this seat is well inclined. In fact, most of the seats in these bodies are built on the floor and frequently made to slide as to be also lowered or elevated according to the requirement of the occupant, and in front to give comfort and make the leg-room and drive in accord with the pedal and steering column. In considering body dimensions it must be understood that though the principal proportion be in leg-room, height and depth of seat, height of body sides, the angle of the backs of seat will be such that will allow of comfortable upholstery for the needful support. Where possible the back and front seat should be of the same height. The sides of the car, to protect the knees of the occupants, the seat backs and shape

PLATE V.



of rails nicely shaped that when deeply upholstered they give support to the small of the back and also a rest for the arm on the side. In the case of very low bodies they must, of necessity, only carry two on the hind seat, the body sitting well in between the wheels. If it is required to accommodate three persons there should be not less than 4 ft. 3 in. between the body sides. The seat must be given the necessary length of clearance for the body to play up and down on the wing without bumping the wheels. The additional length may be gained by cutting semi-circular pockets or recesses or paddle-boxing the sides, but sometimes at the expense of a shallow cushion at this point. If the regulation depth of cushion is required the seat must be kept high. The clearance between the wings and wing and door are points well understood, but that the doors should be hung on forward hinges may not be so well known. There are many advantages, apart from the ease with which they can be opened ; the progressive motion of the car will have a tendency to keep them shut, and in alighting from a moving car the door always goes from you, thus there is less liability to accident. It is important that the front screen should be arranged just below the driver's eyes and give a clear view, especially in bad weather. The fittings for these screens are such that they can be adjusted to any angle and are usually in depth from 18 in. to 26 in. As with body blocks to undercarriage filling up a vacant place is clear evidence of bad design in a new body, so with motor bodies.

Any filling up or blocking strips visible between body and chassis should be avoided, the body should sit well and fit the chassis frame, though this is frequently unavoidable through the changing of the body, when the best should be made of what at all times is a bad job. The strips should be hard wood, well shaped and fitted as part of the body. For cleanliness and avoiding any projecting parts required for a touring body, inside door handles only should be used, as also small but effectual lamps fixed not too far forward. The preceding remarks may be summarized thus (Plate V) :—

(1) The height of frame above ground and depth of body should be as near as possible equal.

(2) Seats should not be more than 14 in. above frame, well sloped backward, and in front giving at least 8½ in. to 9 in. clear below the underside of steering wheel.

(3) There should be not more space than is absolutely necessary between the wheel and mudguard.

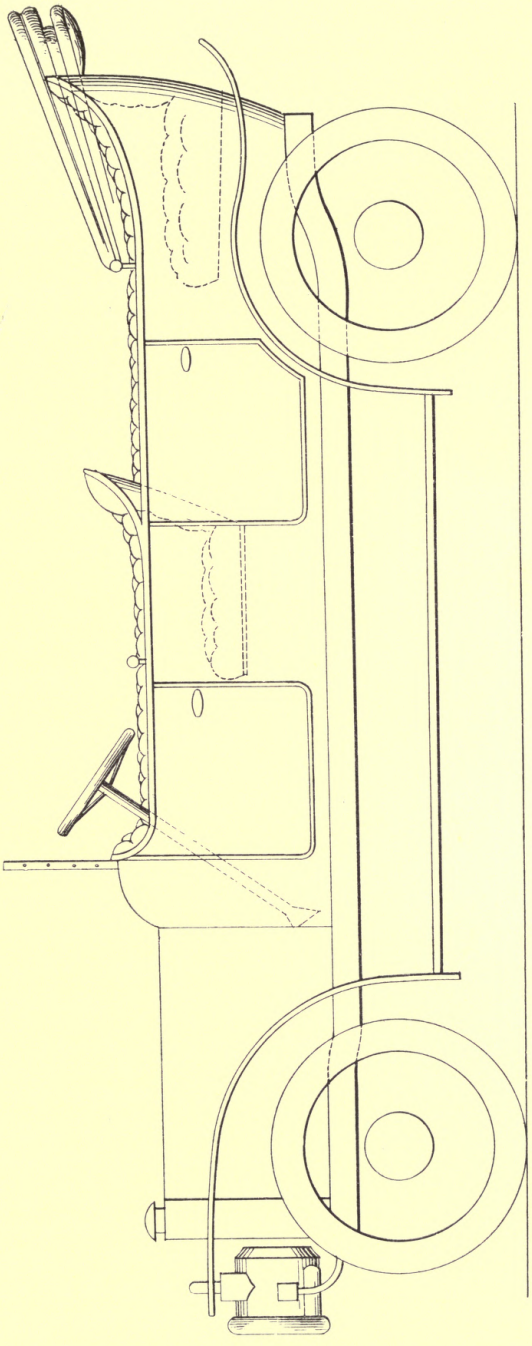
(4) The line of bonnet and scuttle dash should, if possible, run into the line of body.

(5) The rear quarter body panel ought not to exceed total length of bonnet.

(6) The centre of rear wheel and the back of car should be as near as possible alike, avoiding any overhanging.

(7) The clearance at the hind part of wheel and mudguard should be only such as to allow of spring play.

PLATE VI.



(8) All the doors to be hung on forward hinges.
(9) All seats, back and front, to be of the same height.
(10) The height of folding screen not to be above the driver's eyes.
(11) No blocking up pieces between body and chassis.
(12) Front axle centre to be in a line with the radiator.
(13) Head light kept well back and not too prominent.
(14) Small side lamps to be rigidly fixed to avoid rattle.
(15) The hood when down to be flat in a horizontal direction.
(16) Inside door locks and handles or plungers.
(17) Sufficient space between body seat cushion and steering.

Customers' Drawings.—However skilful one may be in drawing many of the lines of body work by freehand, and in making them regular in thickness, with a clear, fine, unbroken line, it is essential that small (for preference) wood patterns be made. Small French curves are useful, but for motor work a special set made by the draughtsman and cut from thin hard wood is absolutely necessary for successful finished work. Box-wood or pear-tree of a thickness approaching veneer is the most suitable wood. The few sketches submitted (Plate VII) may be cut out with a sharp knife or fret-saw, finishing the edges with a fine file and sandpaper, the utmost care being taken to get the edges perfectly regular and free from any inequalities, holes or bumps, so that the " bow-pen " will glide round the edge of pattern. When finishing, the edges of the patterns should be lightly chamfered (knife-edge).

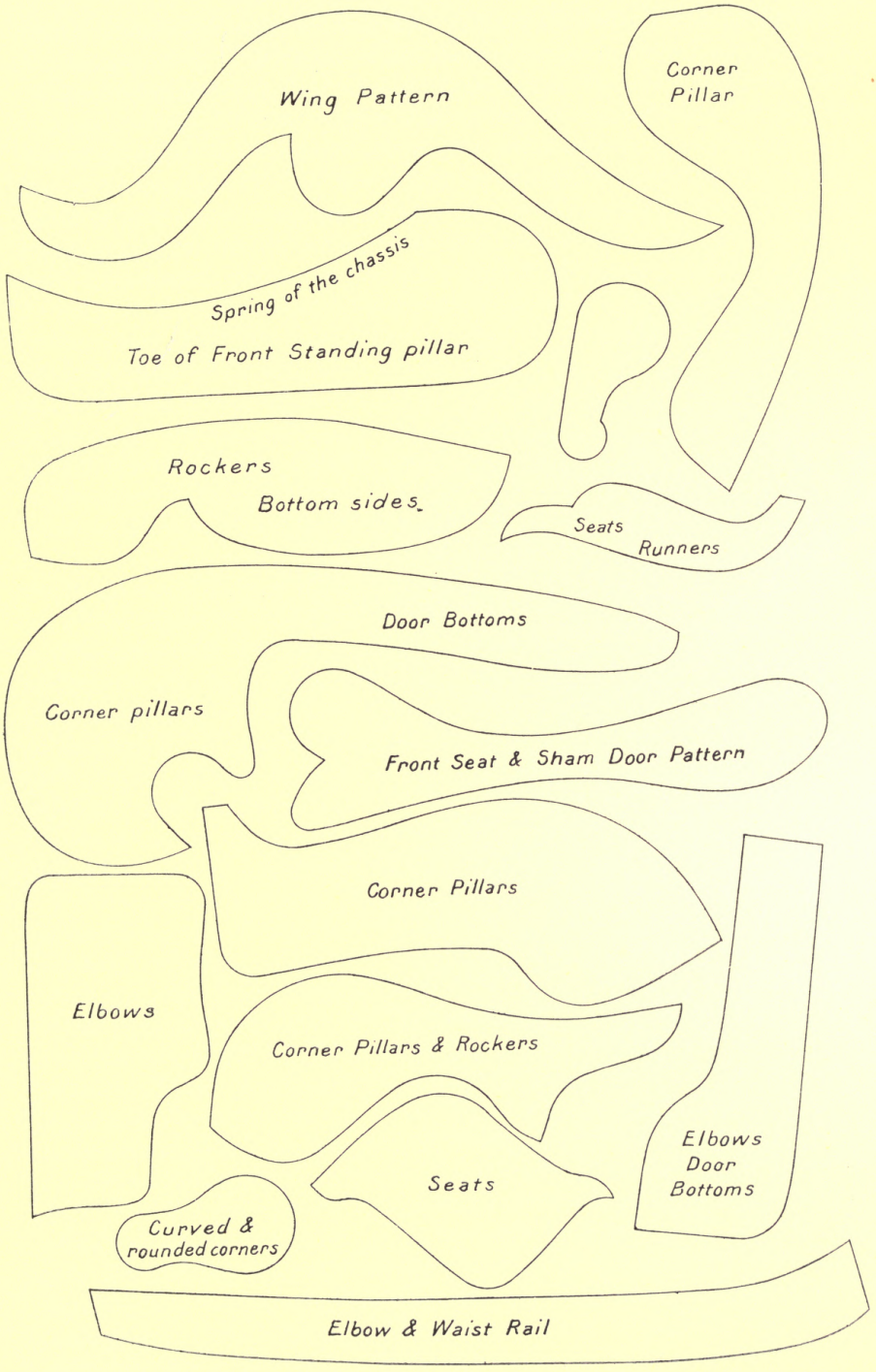
If the edges of patterns are at all jagged, the pen will not work freely and a broken line will show on the drawing.

The bow-pen, it will be found, invariably works better round the outside or convex side of the pattern than the inside or concave side. In the case of moulding lines in small work a duplicate of patterns gives the best results. A bodymaker will, as time goes on, build himself up a set of patterns that will to him become priceless, he knowing the work of each one, then he is able easily and quickly to produce finished drawings. The patterns of an accomplished draughtsman sometimes number some hundreds for finished work.

The Ruling or Bow-pen.—In using the pen, the ink should always be put in with a brush, so that it does not carry too much ink; it is bad to dip the pen in the ink. Before using be careful to wipe the side of blade of pen with blotting paper, as there must be no ink outside the blades. All draughtsmen try their pen either at the corner of drawing, or on a piece of waste paper, and so see that the line is of the right thickness before using.

In using the pen, the construction of same and the shape of blades, as a rule, is such that the head of the regulating screw is outwards. When used keep the pen nearly upright, starting from left to right, working against the edge of ruler or pattern, and go from you with a slight even pressure to keep the two blades of the nib on the paper without cutting it.

PLATE VII.


Wing Pattern
Corner Pillar
Spring of the chassis
Toe of Front Standing pillar
Rockers
Bottom sides
Seats
Runners
Door Bottoms
Corner pillars
Front Seat & Sham Door Pattern
Corner Pillars
Elbows
Corner Pillars & Rockers
Elbows Door Bottoms
Seats
Curved & rounded corners
Elbow & Waist Rail

Do not go fast until with practice you have confidence in your ruling, which is purely mechanical skill, which can be acquired by every one with a little attention. Always start ruling from the top and work downwards, drawing all your horizontal and vertical with your " T " and set square. Use bow compasses, strike in the wheels, curves and other circles required. Small holes, screw holes are best (as with scroll or dub ends), put in with a sable hair brush ; this is far better than the etching pen when carefully used. Small work to be successful should always be done with a magnifying glass.

" Lining in," Inked Drawing, Finished Working Drawings.—The final process on the completion of the drawing in pencil is the working in with the ruling or the bow-pen and may, on the first efforts of a bodymaker, present difficulties. The best ink to use is the liquid indian ink, which is sold in small bottles. A fixed ink that can be toned down with water for light lines is best, and drawings made from this ink can be used, if necessary, for reproduction by photographic process. It is a good plan to take a little out and tone it down and line the whole drawing in with same, afterwards cutting up the drawing by jointing the lines nicely. When two patterns are used or a curved line joins a straight the join should not be seen.

If an inaccurate or wrong line is put in, it is easily removed with the faint ink line. When the drawing is lined, the pronounced lines of body, in fact, all right handed lines, should be a shade darker than those that are in the light. Those may be cut in or lined in with the pure ink, always assuming that the light strikes from the left hand. It should be understood that the drawing should be finished in pencil. If it is done on light paper and is required to transfer it to another the backs of same should be pencilled all over with a soft pencil, then with a piece of folded blotting paper, rub the scribbled lines evenly over the drawing, this may be now pinned down on the card or finishing paper and the drawing transferred through by going over the whole of the lines.

Pencil Shading.—If the drawing be lightly drawn in, the pencil lining should always be ruled, not drawn freehand. The light and shade in a monochrome drawing can be obtained by the aid of a soft pencil, then the paper stump worked along it, using pattern or ruler for guidance, all lines to the right being kept dark. The irregularities of this shading, or the intensity of the tone and the drawing, may be " cut up " with rubber, cut into various shapes, pointed, flat, or chisel pointed. This also is used when cleaning or cutting up against pattern or ruler. Avoid a dirty smudgy appearance, endeavour to get a clear uniform graduated tone throughout the picture. These remarks apply in the same manner to brush drawing.

Brush Drawing should be very lightly put on, gradually getting to the exact shade required. In using the sable brush hold firmly in hand and only brush lightly over the part required, always trying the brush first on waste paper. An end in brush drawing is more difficult to erase than in any other form, as it can only be brushed out with water. All drawings,

when dry and hard, can have their prominent lines strengthened, so that the cardinal points of drawing stand out clear and firm.

The Art of making Customers' Drawings.—The side elevation of the drawing accurately shows the lines of the body and is of paramount importance in judging the design and its merits, while the modified perspective views, now largely used, embrace the above details, and if correctly read and understood, can and do show clearly the more important cross-measurements and position of the many appendages. This form of drawing has distinct advantages. *First*, it is pictorial, and shows the car as it really is. *Secondly*, it shows all details of upholstery, lamps and proper number of wheels, etc., and it is usual in practice to draw it so that it can be artistically treated in colours, in shaded ink, or pencil-shading according to taste. *Thirdly*, it is easy and readily understood, and in the hands of a practical draughtsman, knowing his business, with the proper equipment of patterns and instruments, etc., he can quickly combine the accuracy of a working drawing with the vividness of an artistic picture, which will materially influence the buyer, as he can show in colours the work actually completed and on the road, ready for use. It should be clearly understood that a thorough knowledge of the work is essential, otherwise perspective views would be worthless so far as measurements are concerned.

Colouring and Tinting Drawings.—Beautiful coloured tinted drawings for customers' use can be made by exercising a little care in the brushing in of the colours, which may be the usual water-tube colours. The art really after the actual drawing is finished is to get the colouring uniformly tinted. Always have as much colour in this instance mixed as you require and get as much in the brush as it will safely carry. Putting on your light colours first, cutting up the outline with bow-pen, using the same colour, then fine line the body with the pure colours.

These drawings can be made on " Whatman's " smooth surface cartridge, nicely finished and brush shaded, and will require no varnish. A toned drawing can be made in black and white, the indian ink diluted and brush tinted. A nice drawing can be made in " sepia " brush tinted, while the various browns and umbers judiciously used for the lights and shades give most effective pictures. The drawings in colours, of the large variety of grey-tinted bodies now used are easily made to any shade, as Chinese white mixed and tinted with blue and green will give the desired colour. Always try your wash or colour before using, cleanliness and neatness is important for a tidy and orderly drawing. All mistakes or errors should brush out ; hands should not be continuously resting on the paper or card.

Fully Coloured Drawing for Customers.—These are the most difficult of the draughtsman's art and require the greatest of care, using best material only, for they show the finished car in actual colours, drawn in perspective scales of $\frac{3}{8}$ in. $\frac{1}{2}$ in. or $\frac{3}{4}$ in. and sometimes 1 in.

For the best results they should only be drawn on Bristol-board, sable

brushes only used, and, what is more, only the *very best* pure metallic colours —watercolour—used ; these are expensive, but with care they last a long time. Those in pans are the best ; half pans can be bought at about 9*d.* or 1*s.* each. The drawing made in pencil is carefully transferred to board, say a limousine in blue, with black upper quarters, lemon wheels and body fine line lemon. Care must be used in brushing in the solid colours of blue and black—two or three coats should be sufficient—cutting up the outline with pure colour with the drawing pen, leaving the space for fine line of lemon, for the yellow will clog in going over the blue.

To get a dense black mix a little tube vegetable or lamp black with indian ink, brush in yellow the chassis, cut up with bow-pen. Be sure that each coat is hard and dry before the second coat is put on. The pure colours are dense, opaque and cover well. Thus two or three coats are all that is required. Cut up the mouldings tinted in deep chrome shaded with indian red. Only brush in your ground line. When all is solid and cleaned up, using patterns for all lines and magnifying glass for all small work. Varnish the panels and other parts with a colourless spirit varnish, which can be obtained at the stationer's for 6*d.* a bottle. Allow it to dry hard, as possibly some parts may require two or three coats. Practice here again is the finest teacher.

CHAPTER X

DESIGN AND CONSTRUCTION OF BODIES IN REGARD TO WEIGHT AND ACCOMMODATION.

At one time during the early development of body-building for self-propelled vehicles the use of aluminium was considered one of the most important factors in body work, if the work was to be sufficiently light for practical use and to meet the requirements of the then extraordinary shapes. Though lightness at the present time is considered of no less importance than formerly, it has been found by experience that it is possible to secure lightness by a better proportioning of the various parts of the framing, together with the employment of high grade steels, and also the arrangement and disposition of each piece of framing in such a manner as will give strength where it is wanted, and which while being light will offer the necessary resistance to the load and stresses that are met with in motor body work. Weight is of an enormous importance in the economical use of a motor carriage; a few pounds here and there in the body when on the chassis add considerably to the cost of general upkeep, as well as to the cost of production.

The average weight of chassis from say 20 H.P. to 30 H.P., to take bodies that will give comfortable seating for five persons, is approximately 19½ cwt. The body work to be placed on it, say of the landaulette type, if with seating accommodation as described, fitted with canopy, wind-screen, luggage rail, side-steps, mudguards, with the necessary upholstery and fittings and painting, will probably be some 7½ cwt.; in all 27 cwt. To this may be added many accessories that come in the province of the coachbuilder, such as jack, tyre pumps, levers, tools, spares, etc.; they may add anything from 100 lb. to 200 lb. in extra weight.

It will be found generally that the actual weight of body-work, apart from the wind screen, running boards, mudguards and tool boxes—in fact, all that is necessary to complete the car—is, on an average, less than half the actual weight which may be added to the chassis when completed by the coach-builder. In determining the seating accommodation, an unnecessary length of the cross width means weight by extra timber, metal and upholstery, and in a body with folding hoods not only is the length and width of these increased, but besides the weight it is more difficult to raise and lower the hood, and there is an increased windage. All these factors increase the consumption

of petrol, which it is the aim of the motorist to keep low. Under these considerations it is as well to understand thoroughly the function of each piece of framing, for there should not be an unnecessary bolt or screw, or any superfluous material used; the framework should be lightened where strength is not required, yet at the same time it should be able to stand the various stresses and strains.

If you reduce the structural strength of your framework for some particular purpose you compensate for this by plating with ironwork. For example, curved and bent rails that in shape give twisted and cross grain are usually plated on the inside, while fashion directs certain forms and shapes difficult and expensive to obtain in wood. Metal is utilized for the panels, but sometimes, as with aluminium, it necessitates more battens and framing to withstand the special stresses, therefore is proportionally heavier; and with leaded coated steel, which is a special preparation now being extensively used, the weight is still further increased. It may be said that the difference in weight between the usual practice of framing a body with ash and mahogany panelling is negligible, but the durability and other advantages are strongly in its favour for high-class work, and especially for light body-work. In many cases where we have a sharp curved corner surface, a panel of hammered metal is used with a light framing on either side, but the difference between steel and wood, on so small a part is really not noticeable, but one must consider the advantages obtained both in labour and material. Even assuming that steel is heavier than wood, it is really a question of the practicability of substituting a beaten panel for a twisted heavy pillar that cuts into thick and expensive plank. When a car is fully loaded with five persons there may be some 12 or 14 cwt. above the chassis, and it should be borne in mind that there is much below the chassis, such as stepboards, mudguards, tools, etc., these being all below the level of the frame, and this weight, travelling at 20 miles an hour over ordinary roads, is thrown backwards and forwards from side to side with greater or less velocity, due to the conditions of the road.

These oscillations are not perhaps great, but constant, while the car is in motion, decreasing or increasing with the speed and further intensified each time the speed is checked by the application of the brakes, causing stresses that have a considerable effect on the wear of the body-work.

The usual sign that something is wrong is to be seen at the doorway, by a started joint or the closing in and nip of door, with probable difficulty with frames and folding hood mechanism. While keeping the weight to a minimum with due proportion and proper strength of materials, according to the requirements of design and seating, the composite body (of ash framing, with use of wood and metal panels, strengthened, where necessary, by steel plates), being more rigid and lighter in weight, gives at the present time most satisfactory results, and is far preferable to the all-metal bodies now being strongly advocated. The all-metal bodies are lighter when pressed all in one, but

when of a phaeton type are more liable to accident and get out of true shape; they are most costly to repair, and have a bad appearance in the finished car in respect to paint and varnish.

The metal panels generally used are $\frac{1}{20}$ in. in thickness. Wood panels are usually $\frac{1}{5}$ in. in thickness. The weight of aluminium is 4·7 times that of mahogany for equal dimensions. Steel is three times the weight of aluminium, but is more rigid, therefore a lighter gauge can be used. If all the timber used for framing is not seasoned it will add to the weight. A difference of 7 lb. per cubic foot is found in the same class of timber between that known as "commercially dry" and the "bone dry."

Honduras mahogany is used for framing by some builders; it is lighter than ash.

In panelling a body of a small limousine type 35 lb. weight of timber (if mahogany, equal to 64 ft. super.) will go a long way in the covering up of the framing. Bodies made all of wood are the lightest bodies; bodies of aluminium panels are nearly the same weight, and those of steel panels are the heaviest. The principal difference in the weights of completed motor carriages depend largely on the style and character of the fittings and other contrivances that add largely to weight.

Average Weight of Motor Car Bodies.

Type.	Persons Carried.	Weight.
Landaulette	6	8 cwt. 2 qrs.
Limousine	8	9 „ 1 „
Light landaulette, single pattern	5	7 „ 2 „
Rotund pattern torpedo with double moulding and double Cape hood	5	5 „ 2 „
Phaeton de luxe fully framed with Cape hood	7	6 „ 2 „
Cabriolet with Victoria leather hood, framed boot and rumble seat	2	4 „ 3 „
Interior driving cabriolet, framed and panelled in wood with revolving seat	5	8 „ 0 „

These represent the weights of bodies actually ready for the road and include wings and steps, and it can be understood how these weights mount up when it is said that the glass used in the interior driving cabriolet weighed nearly 100 lb. These weights have been recently taken, and in extreme cases, where lightness has been paramount to all other considerations, the weight of the lightest has been reduced some 100 to 110 lb. In the landaulette the excess weight of the body was 120 lb. The ash framing for a touring body weighs 84 to 112 lb., dependent on shape and ironwork for hood, etc., which may weigh 30 to 35 lb.; the panels weigh from 1 lb. to

4 lb. per square foot of surface covered. The body, when completed for the painter and trimmer, will weigh from 224 lb. to 300 lb.

The question now arises: "What should be the maximum weight of a body for a particular chassis, so that when it is fully loaded it will be equally balanced?"

The correct procedure of weighing a complete car is as follows, and it is quite apparent that with the necessary subtractions the approximate weight can be arrived at.

This is a very vital point in designing, and is often neglected by the draughtsman and the builder. A car must be evenly balanced both for the comfort of the occupants and the equal wear on the set of tyres.

The car must be weighed with all ordinary luggage, accessories, etc., aboard; and with all seats occupied, and all water and petrol tanks full. That is to say, it must be weighed while supporting the probable maximum load.

(1) Weigh the whole car on a weigh-bridge.

(2) Weigh the back of the car; i.e. place it so that its back wheels shall be on the platform while its front wheels are on the ground.

(3) Weigh the front of the car; i.e. place it so that its front wheels shall be on the platform while its back wheels are on the ground.

If the weighing is done carefully, the weight of the whole car should not exceed the sum of front and back weights by more than 20 lb.

When weighing the front and the back of the car separately, see that the wheels, in each case, are placed as close to the centre of the platform as possible. If the platform is too long, it may not be too wide to permit the wheels to occupy a position close to its centre. In such a case then, the scale, if suitably situated, should be approached, by the car, from the side.

Now take a chassis only, and also weigh it in a similar manner. Of course the front will weigh much more than the back. On the weight of the back, add the approximate weights of the occupants, accessories, luggage, etc., and the difference between the total of back weight and the front will give you the nearest approach to the weight that the body itself should weigh in its complete state, that is, with the trimming, glass frames, painting, inside seats, luggage grids, etc., etc., all aboard.

The above is the method of weighing recommended in the Michelin "Guide to the British Isles."

CHAPTER XI

CONSTRUCTION OF THE FRAMEWORK OF BODIES

It should be clearly understood by the bodymaker that though the size, number and shape of the several pieces of framework may vary, not only in each kind of body, but in many bodies of the same class, there are certain general rules that govern the dimensions of the more important parts of the framing of landaulette, limousines, coupês, whatever pattern, side-sweep or turnunder they happen to have. One of the most important is the framing of the doorway. The pillar pattern must be made up to provide for the single runs of the glass-frames that are going to be used, possibly the frames may be "hinged" to fold, or there may be metallic channels for frameless glass, but whatever form is adopted, due allowance must be made for the turnunder, and a good sound fixing for door bottom. It is the size and shape of this pillar that to a large extent determines the form of the hind standing pillar. But the minimum depth of the same pillar from back to front is more dependent on the judgment of the bodymaker, apart from strength and due allowance for letting in the hinges, and a firm fixing for elbow or waist rail, also seat bottom side and rocker, with a good lap on the solid bottom sides, common to the framing of motor bodies. That part of the pillar below the seat is subordinate to the outline of the body, but frequently the pillar may be kept nearly straight. The door bottom sides and the lower part of hinge pillar, being in many side entrances made in the solid, are cut from one piece of timber. The seat, framed independently and contained within the body, is blocked to the right height and pitch. For the front standing pillar the same general rules apply as to turnunder, they having to coincide with the doorway, but the outline differs considerably, more especially at the toe, and hardly two are alike in size or shape, being finished with or without a scroll, and the bottom line following the line of bottom side framing. The size at scroll end may be from 3½ in. to 10 in., but 6 in. and 7 in. are common; but whatever form we require, there should be a sound framing lap from the inside to fix the door-bottom side, which is preferable to lapping the bottom side on pillar.

If the scroll end is then carried on to the bottom side, the joint hardly shows. The size of pillars at the elbow line, though dependent on the form of the body, shape of elbow, the fitting up of folding hood pillars, or on their

being carried through, as in a limousine or other enclosed bodies, should generally be not less than 2½ in. plus the bevel inwards of the shut of the doors. Though there is a certain amount of strain, causing pillars frequently to close by the give of the chassis frame, with this substance they should maintain a perfectly straight surface, on the face side, which is very important, when you consider the amount of boxing out, which is liable to cause the pillars to go round on the face side, so that the door binds and trouble results.

The pillars above the waist or elbow are more often too weak than too strong, which is just the reverse at the hind corner pillar, for above the elbow line in all enclosed bodies the pillars are framed into or on to the cant-rail, which with the battens and panels makes it one of the strongest parts of the body, so that the pillars here have practically little work to do beyond affording sufficient bearing for the panels. The swept or straight door bottom sides are important pieces of framing, being the foundation upon which the upper framing is built, but then the thickness from inside to out is dependent on the turnunder, width of chassis and length on hind seat, wedge pieces between pillar and same to any depth and shape being frequently used. To get a more pleasing outline and correct shape of hind panel, the turnunder on the side sweep should start lower down than it does on the back sweep.

The depth of pillars from top to bottom should always be well considered, for any " extra " step should be avoided for flush bottom.

Many builders prefer a moderate turnunder at the doors with a contracted sweep back and front in landaulette, but with modern chassis and flush-sided bodies very little trouble is now experienced, the curvature both on sides and from elbow downwards being moderate, the only consideration being a good size rear seat. The fitting up of the spring box should be made with due allowance for the clearance of the hind wheels by the roll of the body due to the play of the springs. The runners or bottom should always be strong hard stuff, take a good bearing on the chassis frame at least 2½ in. and also be boxed on top for bottom boards. When made in two pieces shaped to the rise of chassis, a straight flooring inside should be kept, the occupants objecting to their heels slipping on an inclined piece.

A clearance of quite 6 in. is advisable for the differential gear casing. The cant rails in all bodies are important pieces, in folding hoods their size is dependent on the mechanism, in order that a good fixing may be given for the several hinges and grooving ; in enclosed bodies they must be thick enough to afford a mortice tenon for the pillars, and wide enough to work up the side-sweep and to cut notches for hoopsticks and for securing the roof boards and the top quarter panels. The front ends projecting to splice on a canopy rail or an extension front, the back end should be such that you can get a good lap to take a screw into the hind corner pillars and back pillars. In the double swept elliptical roof—expensive pieces of framing owing to the

amount of stuff they cut into—the cant rails may and are put in two, spliced in the centre. The hoopsticks are invariably made of a uniform thickness, but in the case of built-up roofs or three-ply fewer sticks are needed. Nearly the whole of the strain of the roof is borne by the centre hoop-sticks, and with bodies that are to load heavily on top a $\frac{1}{2}$ in. half round edge plate to centre stick is a great tie on the body if made with flaps so as to let into the cant rail.

CHAPTER XII

PROPORTIONAL MEASUREMENTS OF SEATS

THE importance of this chapter cannot be overrated, as it frequently happens that the bodymaker is for the moment unable to tell the width of body on the hind seat, an important measurement. He will at once tell you the width across the pillar tops, or cross rockers, or give several outside dimensions, but may be unable, though building the body, to give hind seat measurements "until tested." In making a cant board, when the necessary points have been squared over and the line of chassis drawn, the width of front and hind seat should be marked off. They are absolutely fixed measurements to which all others are subordinate.

We will now consider these measurements, keeping to the minimum, as any increase within reason will not affect the sale of the body, but a decrease may ; at any rate, it will interfere with the comfort of the occupants. Assuming that we are to carry three persons on the hind seat, then inside the framing anything less than 4 ft. 3 in. is too small. Though we gain something by a deep cushion, we have to allow 2 in. for the side squabs, and each person should have a full 17 in. in actual sitting accommodation when the body is completed. Should the body be for two persons we ought to have 3 ft. 4 in. to 3 ft. 6in., although many are made less than this, but 3 ft. 4 in. between the squabs, leaving a minimum of 3 ft. 2 in. actual seat. So far as regards the measurements given for two people, a wide margin exists from 3 ft. 3 in. to 3 ft. 10 in., but the dimension must finally be determined by the type of body, H.P. of chassis and other details, so that all things are proportionate. On no account should it be assumed that 3 ft. 10 in. or, as one authority says, 4 ft. on the seat will take three persons ; it is a mistake.

Seats Measurements.—It must be understood that increased width means increased width and length of Cape or other folding head fittings ; thus increased windage and more trouble in raising and lowering. In landaulette, coupé, and limousines, besides over-hang of body, it necessitates a heavy pillar cut out of thick plank to obtain the required turnunder, so as to allow the glass to fall, this is especially true of cabriolets which have a deep front light, and in which the front is made low so that when the front corner folding pillars are down they lie level with the top of the doors ; thus a wide seat costs more not only in labour and material, but it

PLATE VIII.

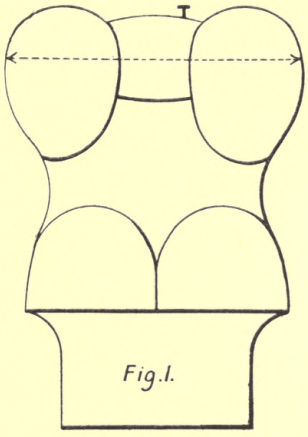


Fig.1.

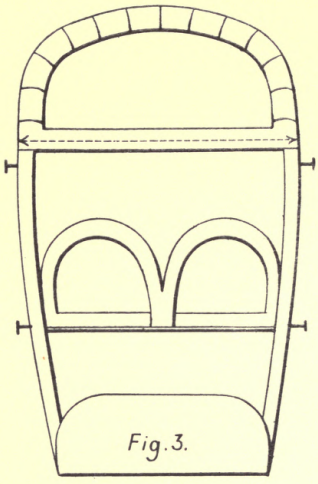


Fig.3.

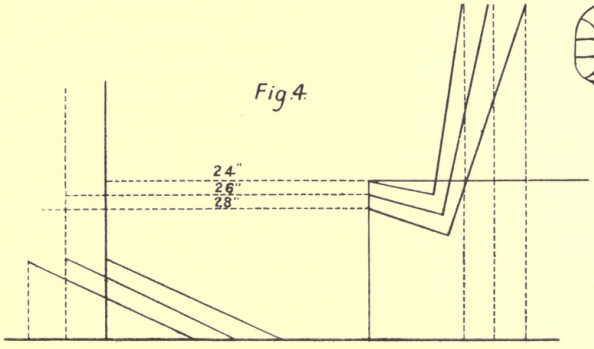


Fig.4.

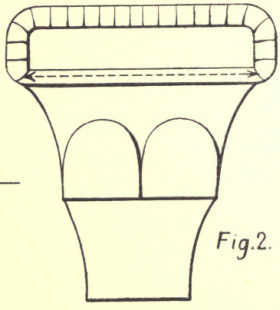


Fig.2.

is likewise proportionately heavier, by the necessary increase in length and strength, but seats should be convenient and comfort should predominate, with due regard to the other considerations.

In Plate VIII, Fig. 1, plan of old form of seats ; Fig. 2, form of side-entrance bodies frequently, and formerly extensively, made ; Fig. 3, plan of flush side torpedo bodies. The dotted lines show where the measurement must be taken in the plan of seats.

Front Seats.—In regard to the front seat we have more often too much than too little, on account of the hind doors, and what is to be arranged to come inside, while a division or case for carrying articles is generally fitted.

Providing we have a depth of seat from 18 to 21 in. a very desirable plan is to keep the near side seat some 1½ in. deeper or more, depending on the leg-room and slope of foot board. In bodies fitted with folding seats inside the driver's front seat, it is well to bear in mind that the actual seat (untrimmed) in a pleasure car should be 15 in. wide, though 14 in. is sufficient for taxis. The distance between the occasional seats (though depending on length of body for comfortable knee-room) should not be less than 1 ft. 8 in., for preference 1 ft. 10 in. or 2 ft. In designing a body endeavour to get 3 ft. between the front rail of body and the edge of hind seat, this with a 22 in. or 24 in. depth of seat will give on the seat line a total length of 5 ft. Assuming that this is so, and the hind corner pillar has a moderate turnunder, we should have a length of body on the waist rail or elbow line of 5 ft. 3 in.

A measurement that has been of long standing is the length of bodies on the elbow line when of the miniature class, especially with bodies for folding hoods and a front inside seat. Measuring the hind seat on the cushion with all the squabs in, 16½ in. ought to be the least amount, though in full size bodies we increase that to 20 in. and 21 in., but endeavouring always to get a 24 in. doorway on the bodies that will open with wing clearance. It is customary now to keep seats low, having a deep cushion, with a frequent pitch of 4 in., but more often the front seat has little or no pitch. The inclination of this seat should be sufficient to the angle of foot board as well as the steering. Another consideration in determining the width of seats is the width of track and sometimes the width and form of suspension at hind part.

It is a bad policy to put a wide body on a narrow track, not only on the point of stability, but because an unequal distribution of weight causes the car to roll, and strain is thrown on to the superstructure that eventually sets up rattle.

Though we have laid down a rule of 3 ft. 6 in. as a minimum head-room for closed bodies, measuring under the cant rail from top of seat, I would suggest that in landaulette and other bodies with folding hoods there should be not less than 3 ft. 4 in. measuring from top of cushion to the underside of hoopstick in the narrowest parts of body.

CHAPTER XIII

JOINTS USED IN FRAMING OF BODIES

All joints should be so arranged that as far as possible the joint may be concealed if not partially hid by mouldings, beading and the panels used, or by the quirks and beading run on the framing to lighten or ornament. It should be borne in mind that no joint is really as strong as the timber itself, while the strength of a body depends as much on the arrangement of timber as on the joints, though the stiffness of a joint is most important. No joint should be used in which shrinkage or expansion would have a tendency to separate the timbers. No joint is really as good as by its own stiffness, to add anything to the framing.

Of the variety of joints used we have the " mortise and tenon " in its many forms, as the double shoulder, bare shoulder, ordinary stump or haunch tenon, the combined lap, mortise, and tenon, lapped halving, spliced dovetail halving, rebate, tongue and groove, ordinary dovetail, notching, butt and wedge, and dowelling all more or less used.

Of late years the bodymaker has wisely discarded the mortise and tenon in favour of the lap joint, as there is no doubt the lap is far preferable when well done. With the two surfaces fitting accurately, the shoulders well up, white leaded and screwed by screws having a slight " draw " it is one of the strongest joints possible. Much is done with bevelled shoulders and tapering laps, and in the case of bottom sides framed to standing pillars, or seat bottom sides lapped either from the out- or inside, the lap should be dovetailed, larger on the one surface than the other, which, besides facilitating the fitting, gives a joint that becomes tighter the further it is driven home, and that has greater resistance. All tenons are best made *one-third* the thickness of timber (using a double mortise gauge), and when they have to resist lateral displacement (i.e. the tendency to draw the tenon from the mortise) should be either pinned or wedged. Though wood pinning is a general practice even with mortise and tenon, it is preferable to secure the same with screws where possible, as when the head of the wood pin is exposed the painter is unable to conceal it permanently, even using the greatest of care with the best material, the end grain of pin being apparent ; again, the practice of driving a peg into the hole to pull or draw up the shoulders is bad, often resulting in undue strain or splitting. In this particular joint all depends

on the good faith and skill of the workman, as when the shoulders of the same are driven home the hidden parts defy scrutiny; the two laps must fit or their several surfaces will not be in accord, but when well fixed with screws it is a sound form of construction. In an ordinary limousine body with a framed top and extension as in a brougham body we have examples of the joints used by the bodymaker. The standing pillars are lapped from inside to the bottom sides at the door bottom and at the top tenoned into the outside. In carriage bodies the corner pillar and bottom sides are frequently in one. In motor bodies with a full quarter the seat framing is independent.

The corner pillar extending from the top rail to bottom runner or framing, into which it is shouldered with a bare-face tenon, is secured by screws, but when carried through to the top at cant rail it is lapped on to the rail and screwed from the outside. The elbow piece or waist rail is lapped on to pillars from the outside, but in the rails care should be taken that laps are made tapering in their lengths, with the extremities bevelled off, so that no end grain shows. In the front they should be notched "back." All elbows are made to rise more or less at the back with a gradual curve, now a notable part of the design, but really necessary formerly to counteract the unsightly effect of a "dropping" at the back part, which was, in reality, an optical illusion, caused by the line of elbow receding from the eye, owing to the round or sweep on the side of the body. The cross bars of the bottom are lapped on to the runners, while the hind bar is commonly framed with the haunch tenon and mortise, as are all the seats when not lapped together. The bottom side runners, owing to the rise in the chassis frame, are made in two and jointed one on the top of the other and when shaping out care should be taken to avoid a feather edge, the extremity being let in $\frac{1}{4}$ in. The front and back cross rails are as a rule "stumped in"; hoopsticks are notched into cant rails that have been mortised on the pillars. The front corner pieces (swept pattern) are spliced on to the rails, as are the back in round corners. In torpedo bodies, with their several battens, the practice is to lap on with bevelled shoulders, while the scuttle dash, hollowed or rounded when framed up, is entirely of the lap and screw form. The shape of top rail is in most phaeton bodies made by splicing the corner, back and side, always keeping the splice as long as possible for good screwing. The most conspicuous joint is the framing of the front pillar at the *toe* into the bottom side pieces, or rockers, where the joint may be vertical, horizontal or at an angle. The best way is to foot the pillar down on to the rocker with a joint running in a line with the moulding, fixing with screws from inside and from the underside. Whatever form of joint is utilized at this point it invariably shows, owing to vibration of the chassis frame. All battens are usually lapped, if possible, from inside and all wood panels in good work should be rebated or grooved into framing, and when two panels meet, the edges should be united. Roof boards are tongued and grooved, but bottom boards are fre-

quently fixed to take in and out, if rebated in. In marking a tenon the grain of wood must not be cross or twisted. Where possible, in screwing or pinning, no two pins should be in a line, but zig-zag. Screwing and white lead is the practice in this country, on the Continent gluing and nailing. A slight bevel only is needed in hard wood to make their surfaces; dovetailing is a source of weakness if overdone. Frequently an exposed joint in a prominent place, such as the front seat panel, is covered with fine silk, glued on and cleaned off.

In making glass frames, screens, etc., the mitre, dovetail, tenoning and other joints mentioned are all made use of.

CHAPTER XIV

STRENGTH AND STIFFNESS OF MATERIALS USED BY BODY-BUILDERS

WITHOUT entering into abstruse mechanics or elaboration of mathematics the following demonstrations and experiments can be easily understood and tested by the intelligent coach artisan who wishes to design and superintend the construction of work that shall be produced upon sound and scientific lines. Taking the material of wood, iron and steel, the specific gravity of a body is the ratio between the weight of the body and the weight of an equal volume of water at a temperature of 39·2° F.

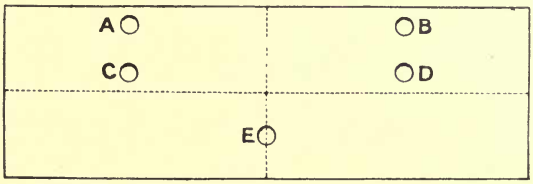
Specific gravity of iron is taken as 7·63, steel as 8; in other words, a cubic inch of iron will equal in weight 7 cubic inches of water, and so on. Thus a square inch of iron weighs just over one-quarter of a pound, and from this standard we can find the weights of iron and steel and timber used in body-making. The practical factory method is to take a piece of 1 in. square iron, 2 ft. long, using it as a gauge for the materials, the same applying to timber used for bodywork. Thus by a practical computation of results the approximate weight of a body when completed can be arrived at. The average weight of a piece of iron 2 ft. long 1 in. square will be about 6 lb. 10 oz., and the various sizes of iron may be computed to bars 1 in. square, with the ascertained weight of the 2 ft. The weight of ash, pine, mahogany, birch, elm, whitewood, and all other woods can be estimated from their specific gravity. For an easy and reliable test of wood for breaking strength take some selected pieces 2 ft. long 1 in. square placed on supports at a given distance, usually 12 in.; by loading them in the centre the bending and breaking strength can be seen. Ash, apart from what we have previously stated as to its qualities for the body-builder, is easily the best all-round wood. The tensile strength of iron is here only given for that used by bodymakers, the B.B. (best bars), 25·75 tons per square inch; the B.B.B. (best best bar), 26 to 27 tons per square inch, but the S.C. quality, a medium brand, is a good one, and experience proves it to answer well for body and other plates. The average tensile strength is about 21 tons, and it should be understood that in wrought iron the shearing strength may be taken as the same as the

SPECIFIC GRAVITIES OF VARIOUS MATERIALS.

	Specific Gravity.	Weight per Cubic Foot.	Break Weight.
English ash	·76	41 lb.	670
Oak	·77	41 „	590
Honduras mahogany	·56	35 „	537
Spanish mahogany	·85	33 „	
Birch	·71	44 „	
Yellow pine	·50	32 „	524
White pine	·43	27 „	
Cedar	·55	—	
Sycamore	—	37 „	510
White teak	—	61 „	814

tensile strength. A noted brand of steel particularly useful is that of the "Park Gate" brand, and some mild steels have a tensile strength of 35 tons per square inch, and special steels frequently reach a strength of 65 tons. The data here given is valuable in arriving at the various measurements of the constructional details, for whenever we increase the strength we increase the total weight, therefore only such an addition of material should be added as is necessary, bearing in mind in the framing that if you double the width you have increased its strength twofold, but if you double the thickness you have increased the strength fourfold. We find in studying the forces and strains on body-work that they act both backwards and forwards, from side to side, and we know the most effectual way to break any piece of iron is to bend it continually.

In pillars where all the lightening out has been done and the rebates morticed for bars, the pillar is almost in two, and the remark is sometimes heard that once it is in and the panels on, all will be well. A little forethought would have avoided this. In arriving at the substance of plates, hinges and other fittings it is as well to remember the effects of an increased thickness over that of an increased width, also in the same manner must care and attention be given to the position of the holes; material frequently



has its strength reduced by injudicious boring or drilling. Take the plate given: the dotted lines are the major and minor axes and the neutral lines. Holes drilled near to these, as C, D, will not affect its strength, but holes

drilled at A and B will have a weakening effect. It is assumed that it is a plate used to strengthen or support some part of the framing, otherwise there should be no holes whatever. Any ironwork that is liable to be subjected to undue strains, such as stays, and acted upon by leverage should not be bored for its connexions, but *fixed by clips or other means.*

There should be no bolt or screw or addition to the material unless it is to fulfil some useful function. In coach-making there are no real data in existence of actual results as to what is a safe load to be carried. In engineering, *Molesworth's Pocket Book* is extensively used for calculations, but every body-builder has to rely upon his judgment as to the correct thicknesses of wood and iron, but in so doing it is important he is in a position to form his calculation on a scientific basis, apart from experience. As to the approximate strength, bear in mind that ash varies very much in its strength, while some qualities of iron and steel are fully three times the strength of others. Therefore his timber should be hand-picked stuff, chosen in the light of his experience for the special work it has to do, while he should be careful to choose a reliable brand or make of iron or steel. For guidance iron may be said to be eleven times as strong, and six times as heavy, as wood. But a testing machine should be used to test all materials used, such as wood plated with steel or iron, cloth, leather, twill, and canvas, the textiles being tested by taking a strip of the material to a given width, holding at each end, and using the ordinary weight pan with steel yard. Bodies are made with the lower framing entirely of metal, to which the upper wood structure is connected, the principles of which are entirely unsound; and, again, bodies are now being made entirely of metal, a false light wood structure carrying the trimming. These forms of construction are not new. The innovation is to cheapen production and lessen weight. Many of these bodies are handsomely finished, especially outside, but the construction is such that after a little wear they are nearly useless. Besides the very mixture of wood and iron, the framed wood bottom is conducive to comfort by destroying all noises. Anyone riding for a full day in either body will at once realize the advantage of the ordinary construction.

CHAPTER XV

FORCES THAT ACT AND CAUSE ALTERATION IN BODYMAKER'S WORK

Some little confusion seems to exist among bodymakers as to the action of these forces, what they are and how made up and brought about. An external force is that which is applied to a body having a tendency to pull it apart, and is resisted by an internal force or resistance ; the action of the force causes a displacement, or deformation, of some part, and in materials a displacement of the molecules. If the reader has studied the subject of " Properties of Materials " he will be able to follow these remarks with clearness. It is commonly understood by many that an extreme force is called a " stress," and the general acceptance of this term can be more clearly understood so far as it concerns the bodymaker. " Strain " is alteration produced by " stress." Really the distinction between stress and strain is not always observed, one being used for the other.

Stresses may be either tensile, transverse, torsional or shearing.

A *Tensile Stress*, or pull, is two forces acting on the body and acting *away* from each other, tending to pull the molecules of the body apart.

A *Compressive Stress*. The two forces act *toward* each other, tending to push the molecules closer together.

A *Transverse Stress* tends to bend a body out of shape.

A *Torsional Stress* tends to twist it.

A *Shearing Stress* tends to force one part to slide over the adjacent part.

To these may be added a tearing stress or strain which is either tensile or shearing, but in resisting which different portions of the material or framework are brought into play in detail, or one after the other, instead of simultaneously as in the first three. All these forces cause alteration of the form of the bodies on which they act, frequently showing in body work by the starting of a joint, which in turn may act on the free working of some other essential part or mechanism.

Take the folding collapsible heads of cabriolets. One of the chief complaints and trouble experienced is that of closing up after being at work some time, chiefly owing to an unequal strain being continually thrown on some part either by inaccurate fitting in the centres or lengths, thus causing a displacement, so that the whole mechanism gets somewhat disturbed and diffi-

cult to move. And sometimes another set of trouble further caused by vibration is the setting up of a rattle, a movement difficult to eradicate. The action of weight in many parts is also cause of strains and stresses, and various methods are employed to resist these, more especially with doors, but the whole framework of a motor body is during life, when at work, subjected to a series of strains and forces tending to alter its form, and which, by being constantly at work, tends to shorten its life. This, of course, all comes under the heading of wear on the body ; and as in a horse-drawn carriage we travel from six to ten miles per hour, working, say, twenty-five to thirty miles per day, while in a motor we travel anything from twenty to fifty miles per hour or from seventy-five to 200 miles per day, it is as well to remember that the wear, consequently the strain, is proportional to the distance travelled and to the square of the speed. Thus one season's use of a motor body is equal to several of a horse-drawn carriage. The object of this chapter is to point out to the reader, and more especially designers, a force or strain acting on bodies, too often not realized or sufficiently understood to the full extent in designing. The tremendous strain on the hind part of a landaulette with a Cape cart, victoria or other folding hoods is bound to be felt by the door, putting an undue strain on the dovetails and frequently loosening the hinges. The doors having been fitted and fixed to the body at the bench should close satisfactorily, but when the body has been bolted on the chassis they may or may not work quite as well. Even if correct when the car left the factory, they may have a strong tendency, on the road, and with three persons on the back seat, and the heavy hood, to open at the pillars, and should the body be hinged instead of bolted to the chassis, the movement may be sufficient to cause the doors to fly open as the car goes along ; at any rate, the natural consequence is a dropping of the doors. To compensate for this strain and avoid this trouble, strong hinges should be used and large dovetails, or dovetails with a catch or double action. These dovetail catches are important factors in avoiding this prolific source of annoyance. In regard to hinges, when there is a lot of turnunder, and where the rocker curves away sharply to miss the wing, or the door is cut away, the ordinary butts are very well, when they can be kept close to the body, but when a long hinge is required they are very unsatisfactory, unless there are more than two and even then they are unsightly.

When strong hinges are required, especially for the bottom hinge, they should be specially cast or selected having a web on them, so as to make them rigid.

CHAPTER XVI

PANEL WORK

For all ordinary purposes with style, good proportion and a fair amount of durability, the present composite body fulfils the requirements. Wood for framework to give the required stability, iron plates for strength and stiffness of structure, with metal panels, either of aluminium or steel for correctness of form. By the use of metal for panels we are able to get a large panel without a joint, and with a beauty of outline difficult and expensive to produce otherwise.

Metal panels also give a good surface for "painting." The wood framing gives a good fixing for the upholstery, locks, hinges and other fittings and appendages, and if the component parts are properly proportioned, an extremely light body with great structural strength may be produced.

Notwithstanding the uses of aluminium, steel panel and stampings in high-class motor body work, the orthodox style of construction is frequently followed, viz. wood framing and mahogany panels ; at any rate, always using wood panels for the side doors and front when possible. In cheap motor bodies a three-ply wood is very much used, especially for panelling or roofing or casing the top and canopy extension. In the modern double-swept elliptical roofs, as with the full rounded back "*Gregoire*" type of body, the roofing is done entirely in metal. To reduce the liability to "sound," the vacancy between the inside and outside roofing is packed, generally with felt.

To strengthen wood panels they should not only be canvassed, but wood blocked on the inside, as, apart from strength, blocking keeps the panel out. But such work should be done with clean fresh glue, and plenty of it, done well and quickly, otherwise both canvassing and blocks are useless.

"*Aluminium*" is supplied in sheets of various gauges, usually Nos. 18 or 20 B.W.G.—that is, 18 or 20 sheets to the inch. This is a recognized standard measure. No.18 equals about $\frac{3}{64}$ in., and is the gauge most useful for beating. No. 20 is used for panels on top, etc., which only require simple bending and fixing. Sheets of aluminium at any standard metal gauge are in three degrees of hardness—hard, half-hard, and dead soft, the half-hard being most generally used. The work of the panel-beater in fitting his panel consist in stretching, hollowing, planishing and smoothing the metal.

Planishing is to make the metal hard and regular with a steel hammer. Smoothing is to take out and make the facets caused by the hammer sink in the metal, leaving the hammered work regular and smooth.

Straight work is easily done by the bodymaker, though if a panel-beater is on the works he understands how to deal with metal surfaces that may contain dents, bruises and sharp corners. A rubbing of paper is taken of the size of panel required, and the template thus made placed on the sheet metal, cutting to advantage, so avoiding waste. It is then temporarily fastened to the framing with cramps and a few screws and accurately scribed round the frame and all holes for lights, etc., marked, also screws and pins. Any final cutting can be done with a fine saw—in fact, any tool with a cutting edge that will not warp the plate; aluminium scissors may also be used, while a high-speed fine circular saw is useful; a lubricant, such as turps, paraffin, petroleum or benzene is used with the drill as it makes the cutting more easy. In filing aluminium single-cut files are preferable to cross-cut.

Steel panels are similarly treated and pinned to the framing. They are extensively used in many factories. Being stiff and more rigid they do not require so many battens—above all, are not so liable to dent, joints and pin-holes can be effectually soldered up and the whole completed with moulding. If no screws, holes or joints can be seen a perfect finish is made. This is important in the rounded or hollow scuttle-dash, entirely panelled in metal, put on in two or three pieces and no joints to show.

Many bodymakers, in putting the battens round the corner of a seat, such as the hind panels of a torpedo or round corner landaulette, often spoil the outline of what might be a smart-looking corner by fixing them in the wrong position.

Now the correct position of the batten is not at that *very* point where the panel should start the sweep round to the back, but about 1 in. before same and nearly $\frac{1}{8}$ in. away from the inside of the panel.

If a panel-beater knows his business, he could beat and put on his panel and be sure of getting a good outline and have no fear of the batten showing through the metal, and, as a matter of fact, the battens should not touch the panels round the corners; and it must also be understood that the metal does not start bending directly at the beginning of the sweep. The placing of the battens within an inch of the actual starting of the sweep may appear to be a small detail, but it makes a vast difference in the appearance of the finished product.

It has been said before now that there are two schools of motor-car body builders—one advocating the use of metal, and the other the use of wood. At the same time there are many builders who cannot be described as enthusiastic adherents of either section, and their work is more or less a combination of the two. Probably, it is the combination system which is mostly used to-day. This may be described as a body which has a wooden framing with sheet-metal panels, as already mentioned. Not very long

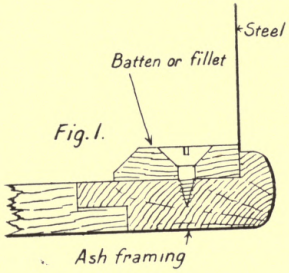
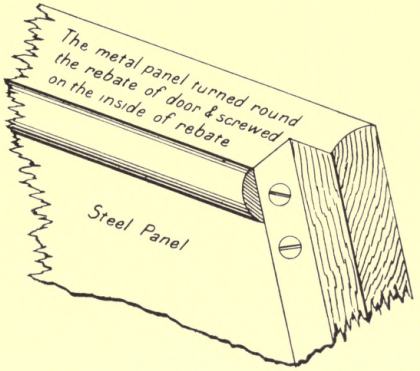


Fig. 1.



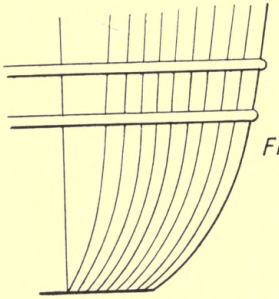


Fig 2.

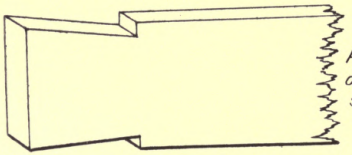
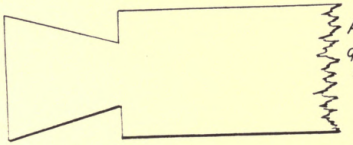
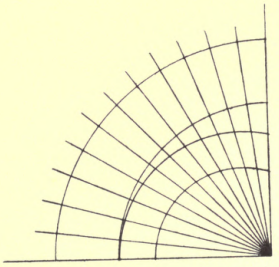
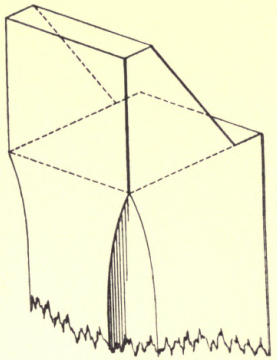


Fig. 4.





Plan of setting out the bevels for wood round corners



since it appeared almost as though the sheet-metal panel would become universally used, but at the present time tendencies are rather the other way; and it may be said that there is a reaction towards the all-wooden body, i.e. wood framing and wood panelling. The popular idea that sheet metal panelling is lighter than wood is not borne out by facts, and I believe the prejudice which exists against wood is due to the fact that in some of the very cheap work unseasoned material has been used. This, too, has gained a bad name for metal panelling, as it has caused the wood framing to warp, and so tear the panelling away. Given good materials and workmanship, there appears little to choose between the two systems, but there are certainly no definite proofs that the mainly metallic body is lighter than the all wood body. There is no doubt that, if aluminium were almost exclusively used, this would not be the case, and, on the score of weight at any rate, the metal panel body would win, but aluminium panelling is most unsatisfactory, as it is so apt to be attacked by the atmosphere, particularly the salt air. Moreover, it is practically impossible to repair it if it should be damaged in any way, though, when it comes to any bad damage, there is very little to choose between aluminium, steel or wood, as the only remedy in any case is a new panel. One great advantage of metal is that panels can be beaten to almost any shape desired. Some very graceful contours can be made in wood panelling, but beyond certain limits of curvature metal wins on account of its adaptability. We dismiss the cast aluminium body used on some foreign cars, also the body stamped in a piece from a steel sheet, because either system is only applicable to cars of the reach-me-down type, as, of course, no variation can be made. The bodies simply come out reproduction of each other without the slightest opportunity for the indulgence of individual taste or the display of originality.

An Untried Type.—The one type of metal body which does not appear to have been developed to any large extent is what one may call the all-metal built-up body, i.e. a body which has all the framing made of angle section steel, the ribs all being bolted to the main body framing and the panels riveted, or preferably bolted, to the framing. This construction may be likened to that of the modern steel ship. Whether it will be possible to make it lighter or more durable than a really good wood frame I very much doubt, and the indications at the present time are all in favour of the wood frame maintaining its popularity with motor body builders, not merely because it is the form of construction for which their experience and training best suit them, but because they have not been able to discover any particular advantages in other methods of building. Whether it is going to remain the final system of body building is another matter, and I need not discuss it in this chapter, but it certainly is interesting to record that, after the tendency appearing to be so much towards the body becoming more and more metallic, it should now frequently be built entirely of wood, except for certain forgings at the door-pillars and other parts, and for

bolting together the main framing. So far as I can see, nothing appears likely to displace the wooden frame, except it should be some of the new metals which approximate so nearly to the lightness of aluminium with the strength and durability of steel, and then it would only be on the score of weight, and after the new metals have not only stood the test of time, but have become comparatively cheap and obtainable in all sorts of sections and thickness for both framework and plating, so that a body could be built without requiring special and expensive work. While discussing body construction it is not without interest to consider the requirements of motorists abroad. There are some parts of the world in which the excessively dry climate, not to mention the white ant, make it desirable that wood should be used as little as possible. So far as I can gather from various reports from abroad, there appears to be no objection to wood merely because a climate is hot ; it depends entirely on the nature of the heat. Humid heat does not appear to have any bad effect on wood, but only excessively dry heat. On the other hand, in a country where the bodies are built by native makers, such as Australia—in parts of which dry heat is prevalent—there appears to be no trouble, this, apparently, being due to the fact that the wood is matured in the climate in which it is to be used. For this particular illustration Australia serves exceptionally well, owing to the high tariff on bodies having made it desirable, if not imperative, that they should be built in the country. Of course, in home use even the driest of dry summers has no effect on any of the woodwork of a car, except perhaps the wheels, unless unseasoned woods be used for the body, and no coachbuilder worthy the name uses such material.

Stampings are fixed to shape, size and pattern, and of course used for cheapness. The great difficulty is to get the various sets alike in shape and free from twist, otherwise the bodymaker finds a difficulty in fixing.

Plate IX (Fig. 1) shows a method of fixing the metal panel without grooving into the framing : fillets are fitted, screwed into place, then taken out and eased, so that when the screws go back they press the panel up tight.

Fig. 2 shows the method of making round corner panels in wood. Many limousines' corners are fitted in this manner, the laminated strips cut out to shape and bevel with band-saw, screwing each together, when cleaned off canvassed all over with a canvas of fine texture. With care a satisfactory job can be made. The procedure of bending wood panels of mahogany or cedar, etc., is as follows : The panel should be trued up to size ; it is then wetted on one side and the other side is applied to heat, such as a gas light, or better still the stackpipe of a stove which is generally used for the heating of the shop, great care being taken so as not to burn it or to heat it to that extent to cause it to become brittle, but in the hands of a skilled bodymaker he can easily tell when the panel is " going " ; then by a little pressure at the right part assist it in bending, so that the actual bend takes place quickly.

Battens are used to keep out and give stiffness to the panel; in wood panels the batten in sweep should be a more pronounced and quicker sweep as, especially, with door panels, they have a tendency to go flat in the centre. In metal panels, all battens should be made to be taken out from the inside, not screwed from the outside, as this facilitates fitting, and in the case of repairs or the beating out of dents, the battens are easily removed. In aluminium panels, bodies with quick and sharp curves, the cross battens should be about 10 in. to 11 in. between each batten, always giving a slight "fullness" towards the centre. If the panel is very deep, cross battens should be put in to give firmness and stability. If metal panels are used for the doors, then the lapping plate should be soldered down all round the panel, otherwise wood panels should be used. Slightly curved or flat panels are always difficult to fix in metal; they should be of a stouter gauge, backed up with a greater number of battens; otherwise bulging will be seen. In bending metal panels they should be bent a trifle more than is required; the pins and screws are to *fasten* it, NOT to *force* it into its place. In worked-up panels, small panels are more easily managed than large ones, beside being cheaper. Thus, if possible, put the panels on in sections, covering the joints with mouldings. Stampings have a wavy undulating surface—in fact, all metal panels are to the eye easily observable, and the permanent appearance is not so good as in wood. Again, metal in panel is stretched if a blow is given, difficult to restore and take out; but in a wood panel well supported it is localized and can be easily dressed out and the paint made good.

CHAPTER XVII

IRONWORK

In ordinary carriage work, the increased strength and reduction of weight and the saving of material in the utilization of body and edge plates is enormous, but, generally speaking, owing to the motive force and the draught, edge plates are not used in motor work, but many corner plates, body and pillar plates are necessary, and in the majority of bodies, the strength, fit and secure fixing of these plates are of primary importance. The dimensions of these plates is a subject on which mere theoretical knowledge is useless, if undue weight is to be avoided, on the one hand, and weakness on the other. So many and varied are the strains, so fluctuating the support afforded by the woodwork, that the only reliable guide is practical experience, from which alone can the plates be made giving strength where it is required and tooled down in other parts. Apart from this, as a rule, all corners should be, if possible, left on the "round." In bodies with frame top and folding hoods it is necessary to ensure that the glass frames and doors shall fit and work freely; hence a cross body iron or a door-way plate, flat or half round, is fitted with cross feet, running crossways or sideways according to the exigencies of construction, and in the fixing of these plates the screws and bolts used must be properly fitted. The "bits" should be large enough, so that the bolt will drive without splitting the woodwork; the drill to take the bolts without stripping the thread; the countersunk should be just sufficient to let the head of the bolt in flush with the surface of the plate so that the latter is not unduly weakened, and for durability the bolt must be fixed with white lead. Then, if good hard body material is used, the stability of the body framing should be such as to resist the many strains. In plates fixed flatways the deeper the plate the stronger it is, but where body edge plates are used it is the practice to employ steel, it being more rigid and consequently lighter than iron for the same strength. The tensile strength of wrought iron used for body work is 22 tons per square inch; cast iron about 8 tons per square inch; malleable iron, 14 tons per square inch; cast steel, 40 tons per square inch; but mild steel has a variable strength of about 30 tons per square inch.

The "*Moor*" quality of iron is generally used; the Staffordshire irons do not forge or weld so well, neither are they so strong. Mild steel will weld with

careful working. The "*Park Gate*" and "*Manganese*" brands are considerably tougher and stronger than the best wrought iron and contain but a small portion of carbon. The best steel that can be used for all general purposes for body-building is the "*Omo*" brand; it can be welded, bent and punched without fear of breaking or splitting, and gives the most satisfactory results, and its cost is about 1*s.* per cwt. more than that of iron. "*Low Moor*" is the best iron for coachwork, but it is not much used for motor work.

Steel is an alloy of carbon and iron, a mixture of carbon and iron. Both bar and plate iron should be able to stand a strain in the direction of the grain of 22 tons per square inch; across the fibre, plate should stand 18 tons per square inch. Drop forgings for flaps, stays and other appendages find favour with many builders, and are strong and cheap.

CHAPTER XVIII

MOUNTING

In order to counteract the "whip" and angular contortions that all chassis are liable to through the rapid passage of the road wheels over the inequalities of the road, and by their exertions with the springs to accommodate themselves to the same, resulting in a more or less flexible chassis frame, various devices are applied by the bodymaker, rather than rigidly fixing his body to the frame, in cases where sound construction and absence of rattle in the body itself are absolutely imperative. The most common practice is to bolt the body down with rubber buffers or thick felt interposed, and sometimes pneumatic tubes are applied, but thorough comfort and suspension with an absence of rattle, strain, creak or movement will never be effectively obtained until the body is in suspension, thoroughly isolated from the chassis frame. All other methods are only palliatives, and no cure for the trouble. At times we are allowed to lower the chassis; if so, Fig. 1 Plate X, is a good job, though it entails some amount of work, as does Fig. 2, which is still a better job. Fig. 3 is a good plan of fixing a plate on the inside. This materially helps the frame. Step stays are of great variety, though it is a question if the forged stays are not better and neater than the cast or stamped, but the flaps on step boards should be strong and of "T" or "H" or horse-shoe patterns, where two stay are used, and three are really necessary. The step boards themselves should be good hard stuff; it is a mistake to use wood of inferior quality. Wing stays, where possible, should be portable, more especially the front ones (see Fig. 5); the flaps on the wings, especially when of metal, should be "T" flaps, with a good fixing on top to carry the bolt head and a neatly made plate or washer or a special made large-headed bolt. Owing to the vibration the wings are very liable to fracture if not of a good gauge, but enclosure on the inside materially strengthens them. The stays themselves should be strong, say $\frac{3}{4}$ in. round, and good firm fixing, with leather between the flaps and other metal to reduce draught and friction. Wings are of various shapes and material, as wood, metal, and, in high-class work, patent leather.

The planished steel wings, with swaged and moulded edge, sometimes have plain rolled wired edges, with inside enclosures and outside flanges or dropped edges. They are made in a variety of shapes. The hollow, or dome, shape will

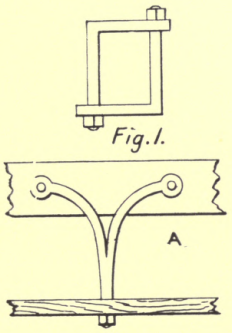


Fig. 1.

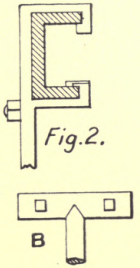


Fig. 2.

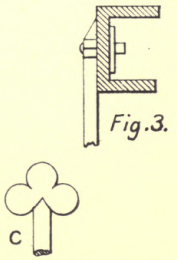


Fig. 3.

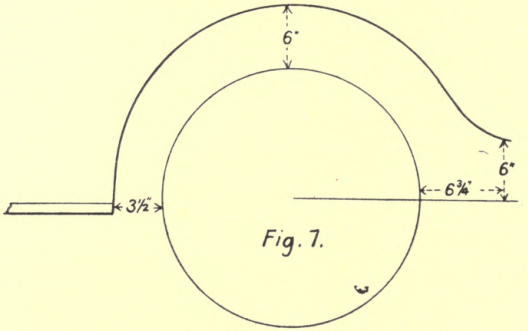


Fig. 7.

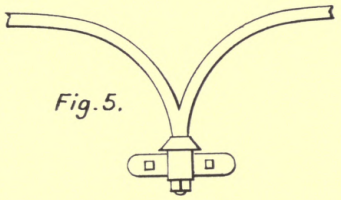


Fig. 5.

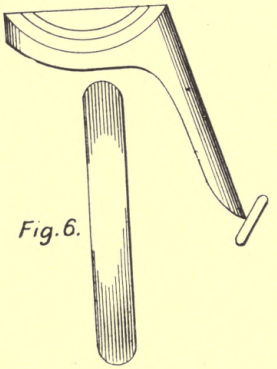


Fig. 6.

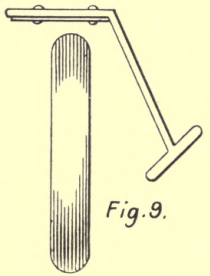


Fig. 9.

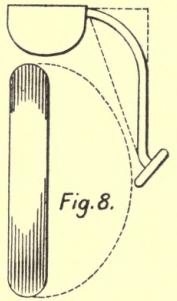


Fig. 8.

be found the most satisfactory, as they fulfil the real object of " mudguards " and at the same time add to the appearance of the car generally. Fig. 7 shows the method of getting the clearance of an ordinary wing, but the clearance necessary between the wing and top of wheel should be determined by the space between the underside of the chassis frame and axle (allowing $\frac{1}{2}$ in. more). Thus, if this distance is 7 in. we should give, with ordinary side springs, $7\frac{1}{2}$ in. clearance, so that the frame touches first. Figs. 8 and 9 show how the turning of front wheel must be measured and taken, and how the shield or enclosures must be shaped to give clearance to the wheel. The proper method of making flaps is shown in Figs. 2 and 3, showing how to take the right size and particulars of dome-shape or hollowed wings. Some cars require a good deal more room to lock than others, so that the space for steering must be taken into account (see Fig. 8). Those that turn in a little over their own length will require plenty of room for the wheel to work, so that the shield will have to be almost square with the chassis ; in other respects, where the lock is not so great, it can be more sloping, as shown in Fig. 9. Wide mudguards are important looking and effectual, while hind wings should fit close up, or nearly so, with the body.

Single steps from 9, 10, or 11 in. wide are now the rule for direct-driven cars, chain-driven frequently being fitted with a double step, forming a sprocket cover or case, with doors of either wood or metal. In arranging for their position, as with all steps and wing stays, accessibility and removability are most important, and it should be arranged that each may be removed independently, if possible. Splayed wings not only throw the mud on pedestrians but offer more wind resistance. Wing stays made with a collar and stump fitting into a socket, the screwed end of large size, are very convenient. Aluminium wings are light, but steel is far preferable, and in general use at the present time. Bent timber is rarely used now for wings ; the cost and time and liability to damage and the cost of painting have caused their disuse. Leather wings are costly to produce ; especially when the expensive enclosures are made in patent leather, but for good class of work leather is still in use. The making of the frame out of $\frac{3}{4}$ in. oval iron, shaping and setting, as with the fixing, require care, but add to the importance of the car. A long chassis frame should always have three step stays in the place of two. In deciding the height of bottom step 4 in. should be allowed for stepping off the kerb.

CHAPTER XIX

DOORS AND PILLARS

Door and Hind Standing Pillars Pattern.—Whatever the form of body, and more especially those with dropped glass frames, too much attention cannot be paid to the accuracy with which this most important portion of the body-work is made. If a full-size drawing is not made, but a $1\frac{1}{2}$ or any other scale, the measurements from same must be carefully taken and marked on the pattern. Assuming we have a piece of $\frac{1}{4}$ in. pine from 9 in. to 11 in. wide and with one edge "shot true," place against the drawing and mark off the bottom of body, the door bottom seat line, elbow or waist line, top of door rail, door top, cant rail and square them over.

Now mark the amount of turnunder, say 5 in. at door bottom, if a gradual continuous sweep. Now the practice with most body makers is to draw in the same with one of their sweep patterns. For clearness the lines that have been squared can be transferred over to the opposite side and on that can be marked the runs of the glass frames, sizes of door rails and door bottom, and it will at once be seen what stuff is actually required from outside to inside to get out the finished pillars of both doors and body. Thus on the one side we may mark our body framing, with its square lines, not only horizontally but vertically; on the other, whatever form of "lights" be used, channels for frameless, angle or double runs for glasses and shutters, so that we can see exactly what timber is necessary. Owing to the turnunder and the glass frames being always straight, when we lift over the fence plate or lift off the door rail, to drop and slide into position it will be understood that the rebating out is not in a straight line where frames are used, for when down the glass frames must fit top and bottom, and when up they must fit at the rail and door top, otherwise we get rattle. When supports, flappers and channels are used the glasses are held by these, but with ordinary frames they should be held tight by the boxing after the body is painted, the frames being covered with cloth or polished, so that they are at the same time easily movable up and down, without any rattle, in either position. To be sure of this the bodymaker will provide himself with a short straight edge planed to the thickness of the frame finished, $\frac{7}{16}$ in. or $\frac{1}{2}$ in., or whatever size, and the depth of glass of frame in length. Marking the thickness of door rail on the pillar pattern from outside, he can place the

PLATE XI.

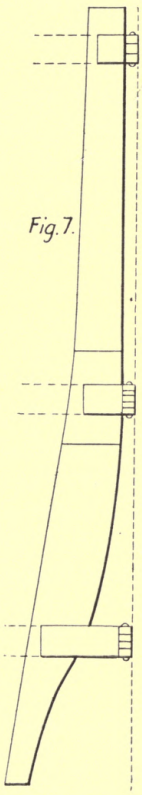


Fig. 7.

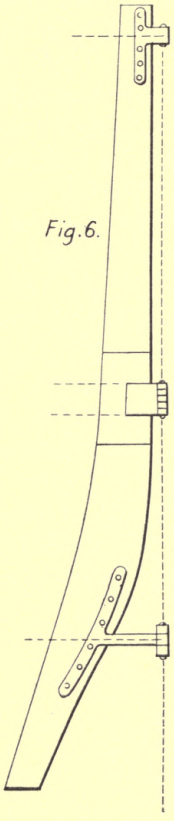


Fig. 6.

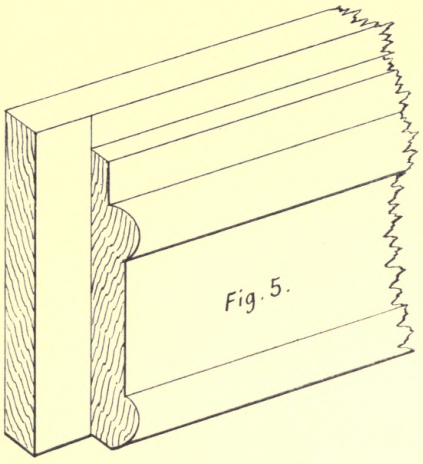


Fig. 5.

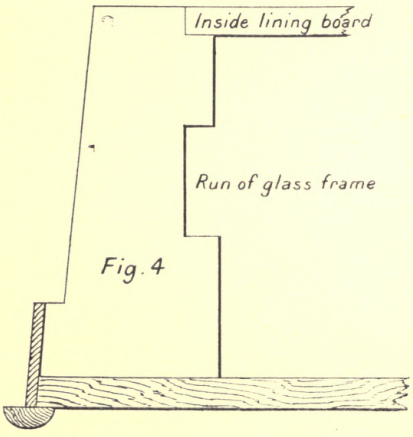
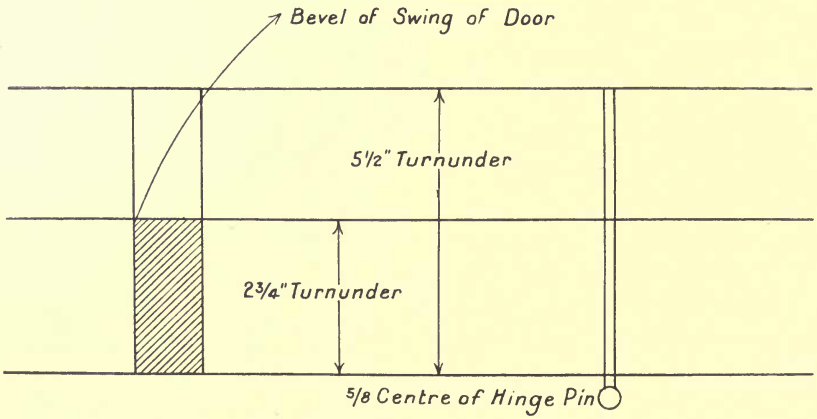


Fig. 4

straight edge on, mark the frame up, and the position lifted over the fence plate. He will now raise the stick for guidance, the stick to line on the top part of pillar pattern, put in a few pins, gradually lowering the stick, keeping against pins, marking on the outside the shapes it assumes until it is down level with the fence plate at top. The size of frame being now seen, the thickness of door bottom lining boards and door top rail must be put in, and that will bring your pillar under ordinary circumstance 3 in. or 3½ in. thickness at elbow line, in some cases lighter, but if there are double frames, blinds and glasses an extra ¾ in. is allowed, because of the lips or flanges to separate the same when down, though when in use, they use the same boxing above rail.

"Doors," their Construction, Fit and Method of Hanging.—No part of a motor body, in its construction of the framework, should have more attention paid to it than the framing fit, hanging and perfect adjustment of the side-doors, which, as all bodymakers are aware, are made and hung in various forms according to the type and style of body, but all of which forms may be classified into two kinds: half-doors, seen on landaulette and phaetons; and the fully framed doors for the larger and more important types of bodies. We can and do make a difference in the thickness of the hinges and shut of same, ¼ in. or ⅜ in. in a shut of 2¼ in., but we find that 1¾ in. is sufficient in thickness with the modern practice of using "brass butt hinges" in the place of the concealed hinges formerly used in coach work, while for motor bodies the "boxing" out for door rebate on the hinge pillar should certainly be ⅜ in. deep on the shut. Whatever opinion may exist as to the thickness for a sound, perfectly made door, this thickness depends entirely on the "turnunder." As you increase the turnunder so should the thickness of door pillar be increased, so as to maintain a firm fixing for the door bottom, as shown in the sketch.



It is apparent that 2¼ in. may not be then suitable for all bodies, owing to the lower part of pillar, below the "elbow" or waist line, having to be

PLATE XII.

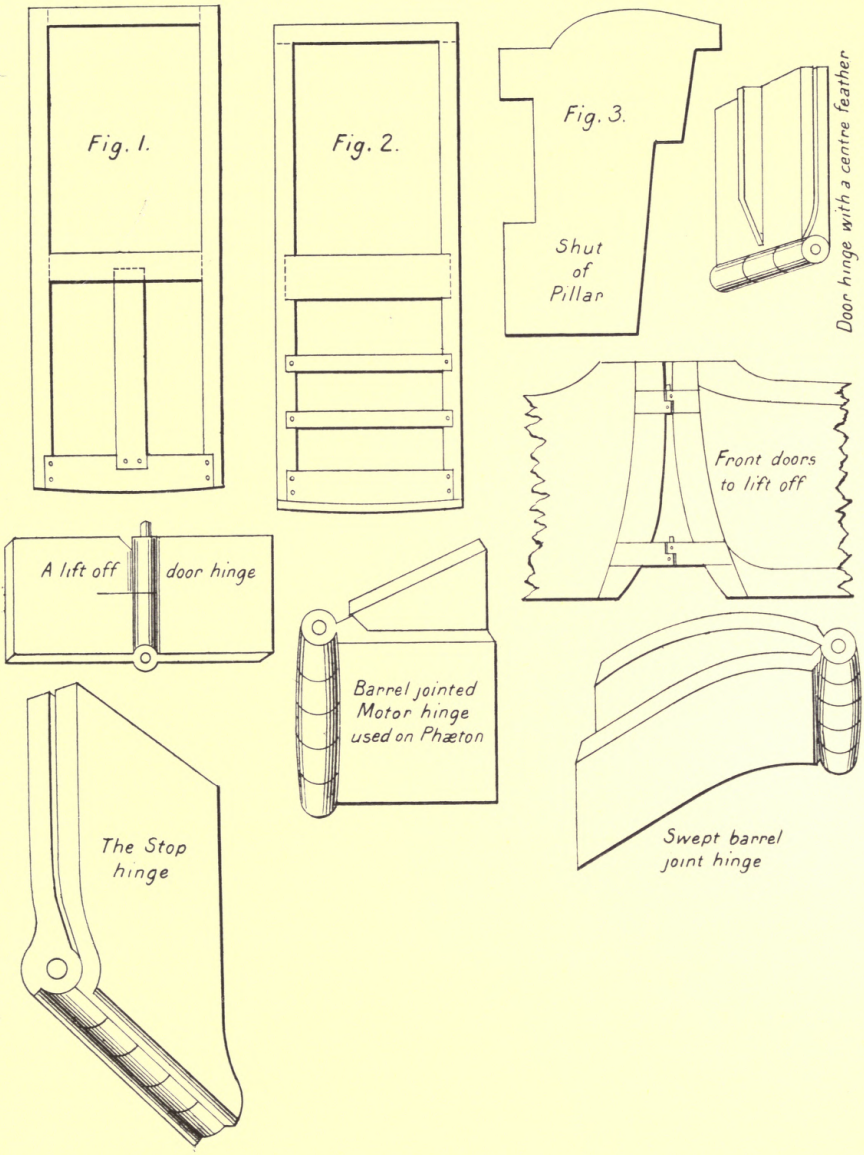


Fig. 1.
Fig. 2.
Fig. 3.
Shut of Pillar
Door hinge with a centre feather
Front doors to lift off
A lift off door hinge
Barrel jointed Motor hinge used on Phæton
Swept barrel joint hinge
The Stop hinge

"shot" or worked off in a line, or out of " wind " with the bevel of the upper part, which is planed to the bevel of the shut obtained from the cant board. English ash is the timber generally used for pillars, as it is for rails, but deep door rails in the middle are commonly made of mahogany and sycamore as well as poplar. The door bottoms are often made of acacia or oak, owing to their wet-resisting properties.

The Framing Joint.—The stump tenon and screw is for all doors undoubtedly far preferable to the mortise and tenon right through with end grain showing and secured with a wood pin. The shoulders of the middle and top rail of door should be in a line with the $\frac{1}{2}$ in. wasting usually shown round the light line of doorway; that is to say, that if the measurement between the two pillars is, say, 1 ft. $7\frac{1}{2}$ in., the length over shoulders should be 1 ft. $8\frac{1}{4}$ in. The battens used to strengthen the doors and panel are both lapped, tenoned and halved on the framing, and may be arranged to run crossways or vertically, as may be. Two narrow battens may be used in the place of one wide one. In the case of wood panels of mahogany the position of battens is dependent on the direction the grain of panels runs.

Wood panels are preferable to metal for many reasons, though aluminium and steel (gauge 20) are commonly used. When in this case, for a good job, the door lapping plating should have the edges resting on panel and soft soldered all round, otherwise a broken edge with cracked paint is soon apparent, no matter how well the painting is done. On door bottoms the moulding is frequently planked on, and then worked out of the solid. While the mahogany panel is glued to the framework, it should, after cleaning off, have its edges pinned all round the lap plate and mouldings covering the heads. The panel is grooved up in this case to the middle rail. When metal panels are used they are frequently carried right through and the door mouldings put on. All wood panels are well canvased on the inside, blocking the edges all round, canvas-blocking, if well done, being stronger, while the panel may be further strengthened by solid blocking all over, especially necessary for motor bodies. As all door panels have a tendency to go flat, the battens should be put in of a slightly quicker sweep than the side sweep, keeping the curvature of the panel a little more pronounced in the centre.

In the hinging of doors use the plain butt, cranked or feather-edge, flanged or barrel, pattern to lift off, with or without an out-rigger hinge of iron, but under most circumstances either one or two on the side should be of the stop back pattern. Straight hinges may be used with good wide doors, for in all cases we should in the side doors endeavour to get a 22 in. to 24 in. clear uninterrupted entrance to the body. In hanging of doors the main point is to have the centre of hinge right. The hinges let in standing entirely square, both sideways and endways (*see* Figs. 6 & 7, Plate XI), keeping the top hinge as close as possible, the distance the bottom hinge stands out can then be taken by square board, and the middle hinge conveniently arranged in the centre of doorway moulding, usually above elbow line. The bottom one,

while sufficiently low down to give strength and to do its work, is dependent on the framing and style of body as to its exact position, though it need not as a rule be where the turnunder is quick, but just where it starts. It is the practice of the day to have doors open square for appearance ; thus, owing to the turnunder, the bottom hinge stands out considerably. To save this, we might have a longer top hinge ; then the door would not open square, but fall at an angle. But whatever arrangement is made the hinges must "line." In many flush-sided bodies the framing is entirely square. Thus the hinges can always be let in at the bench on standing pillars, but for preference fully make the door, then proceed to hang same. Assuming the hinges are let on to the standing pillar the door may be put into its right position, holding with cramps, and with a bent marking awl or scriber mark hinge on door and let in, if necessary, and try door with a screw in each flap. In trying the door, assuming it comes short of the shut pillar, carefully take a shaving off the inside, straight through from outside, on either pillar, which you think best. Say it drops a bit at shut, let the bottom hinge in a trifle ; that is, sink it into pillar, being careful to remove the shaving away from the outside bearing below its level, the slightest amount will turn a door, and a sharp bevel-edge chisel, thinly grounded, should always be used in finally fitting doors. I should favour a neatly made outrigger hinge for the bottom, with flaps as shown in Fig. 6, Plate XI. The "T" flaps, when used, considerably strengthen the doors, but the same amount of care is required in hanging these doors, and should they drop they should *never* be forced or twisted into position or the screws tightened up, but the centre bolt taken out, and with a light twisting wrench throw round the bottom half slightly to bring into position.

Butt hinges are delivered that the holes may be drilled in any position required, using No. 8 screws for fitting, and No. 10 or 12 for finally fixing.

Grooving, or boxing out, for the glass frame runs on the inside of the pillars should be $\frac{5}{16}$ in. deep. With frameless glasses the channel that the glass slides in is covered with felt, cloth or velvet, which gives the size and depth to be rebated out.

In fixing the channels a good practice is to leave the lower extremities loose, then they move with the glass when let down. The glasses moving or lifting over the fence plates are preferable in many respects. In grooving below the middle rail the frame should always be kept off the rail, so that a lip of $\frac{1}{8}$ in. is left on. The outside rebating of pillars for shuts have been mentioned as $\frac{3}{4}$ in. and $\frac{5}{16}$ in., but many bodies are made having no rebate up the hinge pillar but a narrow plate on the inside, keeping out light and draught, while the ease with which the door may be hung and fitted is considerable. Again, many fully framed doors have the door lapping plate carried right up to the door top, thus dispensing with the double boxing above the elbow line to form a flange. But whatever practice is followed, $\frac{1}{8}$ in. clearance for paint must be given, a gauge being used for this purpose.

Besides the considerations already given for the thickness of shut (approximately $2\frac{1}{4}$ in.) it must be understood that in boring for the spindle of door-lock sufficient stuff should be allowed inside the rebate for the hold. The shut pillar and the closing of the door should always fit " dead true " top and bottom, with a slight draw in the centre ; thus the pillar is fitted a little off in the middle. It is a very good plan to give front of door $\frac{1}{8}$ in. more turn-under than the pillar pattern, so that when the door is locked, it will touch top and bottom with a slight draw in the middle, and be quite taut and free from rattle. Not all doors are made square, but the pillars are sometimes got out to the contraction line of the rocker, the bevel of which is taken from the cant board. In many square doors a bevel of a $\frac{1}{2}$ in., or little more, is sufficient, and when the body is squarely built the curve or sweep on the side and swing of the door helps it to reach its bearing. Most doors are finished with a $\frac{3}{4}$ or $\frac{7}{8}$ in. brass or aluminium door lap plate, beaten to the turnunder shape, and well set from any irregularities and fixed all round, allowing the usual clearance for paint. Some landaulette doors have the panels grooved in, showing a vertical moulding as well as on the rails. In modern body-making the work of getting out and grooving is done by the spindle and other machines, but in many shops the doors are made entirely by hand, and it is here that the " router " is an important tool in the hand of a good man for French sinking ; side and finishing routers are all used. Briefly the manufacture of a door is as follows :— The stuff is sawn out and planed to thickness and bevel required. The middle rail and door top rail is framed in with a stump tenon in. long and screwed. The shoulders are let in $\frac{1}{2}$ in. beyond the face of the pillars level with the half waist line in the pillar and door top rail. The pillars are then taken apart and the glass runs and the rails marked as previously explained, also the $\frac{5}{8}$ in. to allow for thickness of moulding and door panel. After the rebates and runs are boxed out, the mouldings worked up, and the middle rail and door top are boxed out, they are put together, and the door bottom fitted and battens framed into the rail and lapped on to the door bottom from the outside, fixed with screws. A stretcher is screwed on to the back of pillars to keep the door frame in position, and short props of wood put in between the stretcher and batten to prevent them from going flat with the pressure of the panel when it is cramped and glued on and canvased. When dry the door may be hung and the garnish rails fitted, the fence plate screwed on. After thoroughly painting the inside and the water-holes cut or bored in the door bottom, the lining boards are put in, the dovetails and lock fixed, finally finishing with fixing and setting the door lap plate.

Points to be Considered in Fitting Doors.—The inside of garnish rails should be hollowed out always and the lower edges of rails and battens well rounded over to allow glass-strings or raisers to work freely.

Grooves and water-holes should be large and sunk deeply in the door bottom to carry off water and dirt.

Dovetails fitted top and bottom with a two-way action, or one in the centre below striking plate should be a large $\frac{7}{8}$ in. one.

Glass-frames' rests or the door bottom should always have rubbers fixed to take the fall of the glasses or frames. A wide $\frac{3}{4}$ in. thick stout birch board screwed in a lining board considerably strengthens it at the lower part of doorway and protects the doors against springing and liability to rattle. In lining out the pillars for glass runs be particular that the "try stick" slides freely, but fits tight at the door rail and bottom when down and at the door top and fence plate when up, a $\frac{1}{16}$ in. being left on grooving to keep frames "off" rail.

The try stick must exactly equal the thickness of frame when finished, either polished or covered. In half doors with folding hood, glass frame supports are used, so that the door may open with frames up, dispensing with the old lever lock that always secured the door when glasses were up. The channel supports fitted to the door should be firmly fixed, with extremities fitted, so that when down and not in use, the wet will not get in. Spring and sliding channels are very effective. A door handle should be fitted that no strain or force be used to get into its place. The position of door handles should be on the outside in a line with the individual shoulder. The new "plunger lock" is a good and useful arrangement and easily fixed. Slam locks should always be used, and the bolt when shot home off the bevelled striking plate locks the door tight and free from rattle when finished painting; thus this must be allowed for in the mortise. The striking plate should be strong and the stop faced with steel of a good thickness and well bevelled.

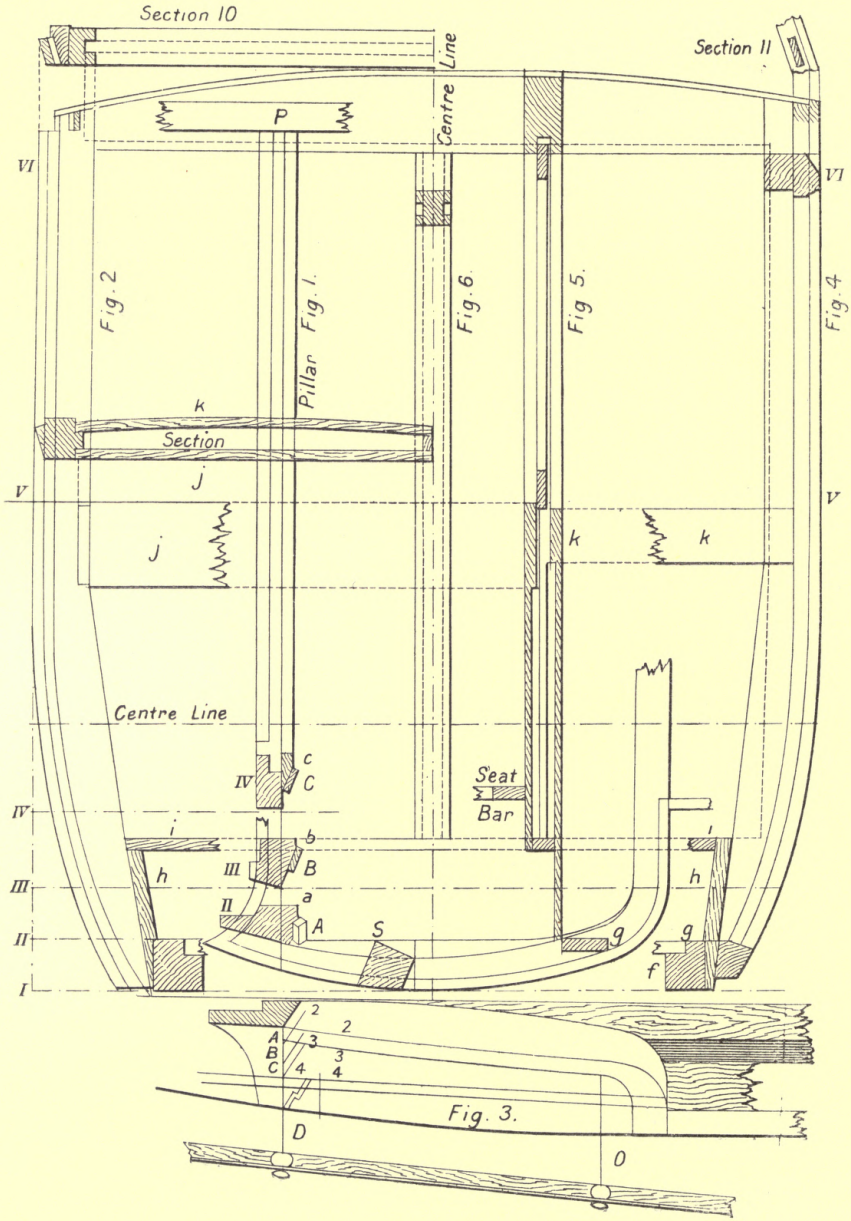
All dovetails in large bodies should not be less than $\frac{7}{8}$ in. If one is used, let it in just below the lock, and it should be of a two-way action, so that the possibility of rattle is reduced to a minimum.

Setting out of Front Coupé Pillar.—Elevations and plans of bodywork generally have been explained. The object of the following lesson is to teach the reader how to lay out a front pillar in detail, a most instructive problem, besides which the accompanying drawing (Plate XIII) shows briefly the ordinary construction of the front of body. The side-sweep and amount of turnunder being decided, and the plan drawn, we proceed to lay out the shut bevel of the pillar. The bevel at the elbow or fence rail, where the lock is located, is from that point to the top quite the same bevel.

Lay out sections II, III, IV, V, VI, Fig. 1 (Plate XIII), corresponding to the section lines 2, 3, 4, 5, 6 in Fig. 3. Determine upon what radius the door will open in the swinging at sections 2, 3, 4, 5, 6. At 5 the bevel is the same as that at the elbow line, and the door should open without any trouble, but we cannot carry the one bevel on the pillar below section, as the turnunder carries the door farther away from the centre of the hinges, necessitating a greater bevel, in order that the door may open freely.

By trying the shut bevel at each section in Fig. 3, with the "trammel"

PLATE XIII.


Section 10
Section 11
Centre Line
P
VI
VI
Fig. 2
Pillar Fig. 1.
Fig. 6
Fig. 5.
Fig. 4
k
Section
V
V
j
j
k
k
Centre Line
IV
c
C
Seat
Bar
IV
i
i
b
III
B
h
h
III
II
a
A
S
g
g
II
f
I
2
2
A
B
C
3
4
3
4
Fig. 3.
D
O

points, it will be found that the greatest bevel is at the bottom of door. Set the trammel points from O to the rear outside edge of the coupé pillar in Fig. 3; at each section describe an arc cutting the inside and outside edges of the door, and connect intersection with a straight line, thus establishing the bevel at which the door will open at each section. In order to obtain a really perfect fitting door, the front and shut pillar should be worked off to these different bevels, notwithstanding the inside face of standing pillar is slightly on the twist below the elbow line, and notice also that the bevels of front pillars as a rule are worked each time from the rear outside edge of the pillar. This gives us a straight line for the front of door and rear of pillar in Fig. 1.

In Figs. 2 and 4 (Plate XIII) we have shown the top cross rail framed into pillar by means of mortise and tenon seen in section 10. Figs. 1 and 4 represent the top and roof rail into which the front pillar is framed. This is clearly seen in Fig. 2.

Between the two front pillars there are two drop lights which require a centre pillar (Figs. 5 and 6). This centre pillar is framed at top by a mortise and stump tenon and is lapped on to the cross bar (Fig. 5).

Figs. 2 and 5 represent the middle cross rail mortised into the pillar as shown in Fig. 2. Some bodymakers prefer to half lap it to pillar to pillar. K (Figs. 4 and 5) is the garnish rail on the inside of body, on to which is secured the upholstery, also the polished garnish moulding. H, in Fig. 2, is a batten framed into runner F and the cross bar i.

This gives a bearing for the inside of the coupé pillar, which is secured by gluing and screwing. P (Fig. 4) shows the roof rail rebated out to receive the three-ply roof board.

Fig. 5 shows the sections of coupé pillar, cross bars and garnish rail at the elbow or fence line. It will be noticed that the garnish rail V and K is in two pieces and swept to give good clearance on the glass frame or window pulls when the lights are raised or lowered; this should always be done. A study of the drawing will again show by reference lines (—.—.—.—) the importance of the square line and how working is developed from the same.

In Fig. 5 the glass frame is supposed to be up. The bottom frames for all good body work should have $\frac{1}{8}$ in. by $\frac{1}{2}$ in. brass angle, permitting one web of the angle to straddle the fence plate instead of having the complete frame to jump the fence as is customary in most cases.

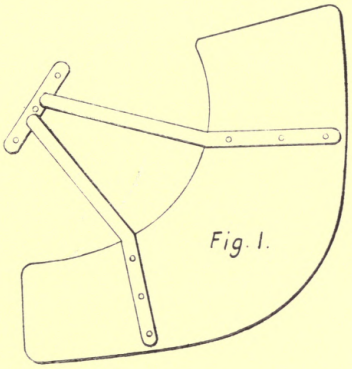
CHAPTER XX

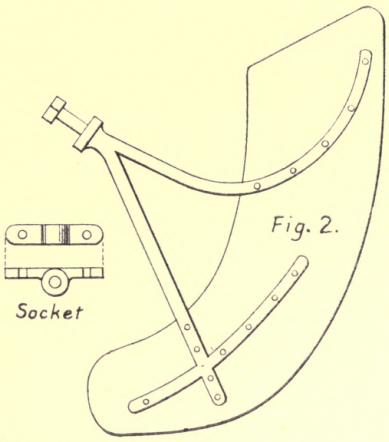
MUDGUARDS: THEIR SHAPE AND ARRANGEMENTS TO MEET THE BEST CONDITIONS

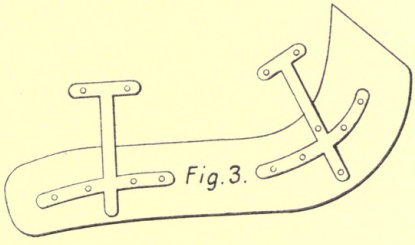
THE above at all times is a question upon which diversity of opinion exists, but by a reference to sketch it will be at once seen that to secure complete immunity from mud splashing and afford protection not only for the car but for other vehicles and pedestrians, Fig. 1 (Plate XIV) is undoubtedly the best shape, and to a certain extent we meet this in fixing the " Dome-shape " or " *Francona* " pattern, but where possible, to get even better results, these shapes may be continually improved upon in many respects with advantage, and to accomplish this the direction in which the tyres splash the mud should be studied carefully. The front wheels cause it to be thrown both in a rearward direction and laterally when the car is going straight, also when the wheels are locked. Theoretically, if the car is moving in a straight line, the mud should be from the front wheel, beneath the underside of the mudguard and the running board, but it will be found, however, to be showered on the side of bonnet, the back of the guard and the top stop board. This shows that mud flies off from the tyres at a tangent direct as well as laterally. To a smaller extent, because of their fixed path, this same peculiarity may be seen in the hind-wheels, and it should also be understood that the angles taken by the mud showered off the tyres are wide, and the streams spread out in all directions, thus clearly showing that the flat wings seen on an ordinary horse carriage are not the best form for motors.

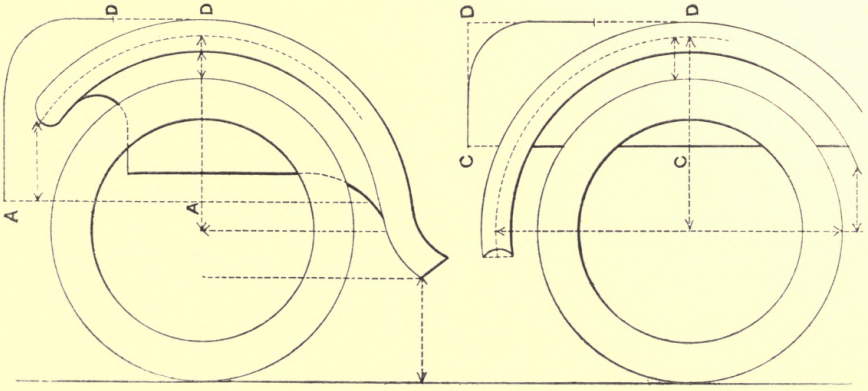
In order to be effective, guards should be much smaller than generally seen, and as close to the wheels as circumstances will permit. Other influences at work to create mud-splashing, apart from velocity, are the wind encountered in the air currents set up by the passage of the vehicle, the draught created by the wheels in revolving and the meeting and overtaking other vehicles, all adding to the force wherewith mud is bespattered over a car as well. Figs. 2 and 3, Plate XVI, show how ineffective the ordinary shapes are, and represent something of what takes place, as from such forms a fan-like stream of mud is projected all over the car from at least one-half of the periphery of the wheels. The force at which the mud is thrown varies, of course, with the speed of the car. Mechanically speaking, the reason why the guards in Fig. 1, Plate XVI, largely overcome these difficulties is that they

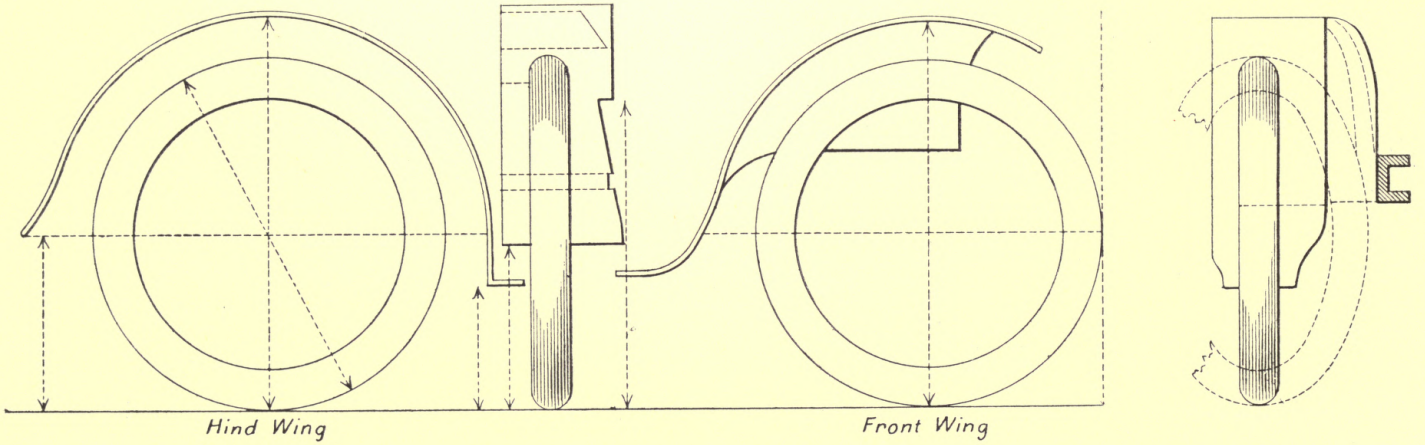
PLATE XIV

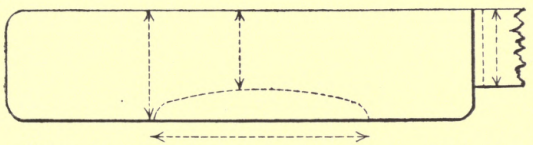




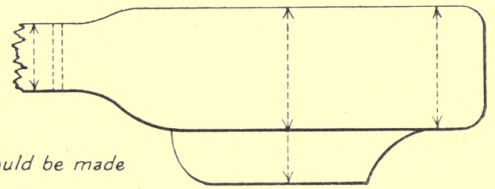








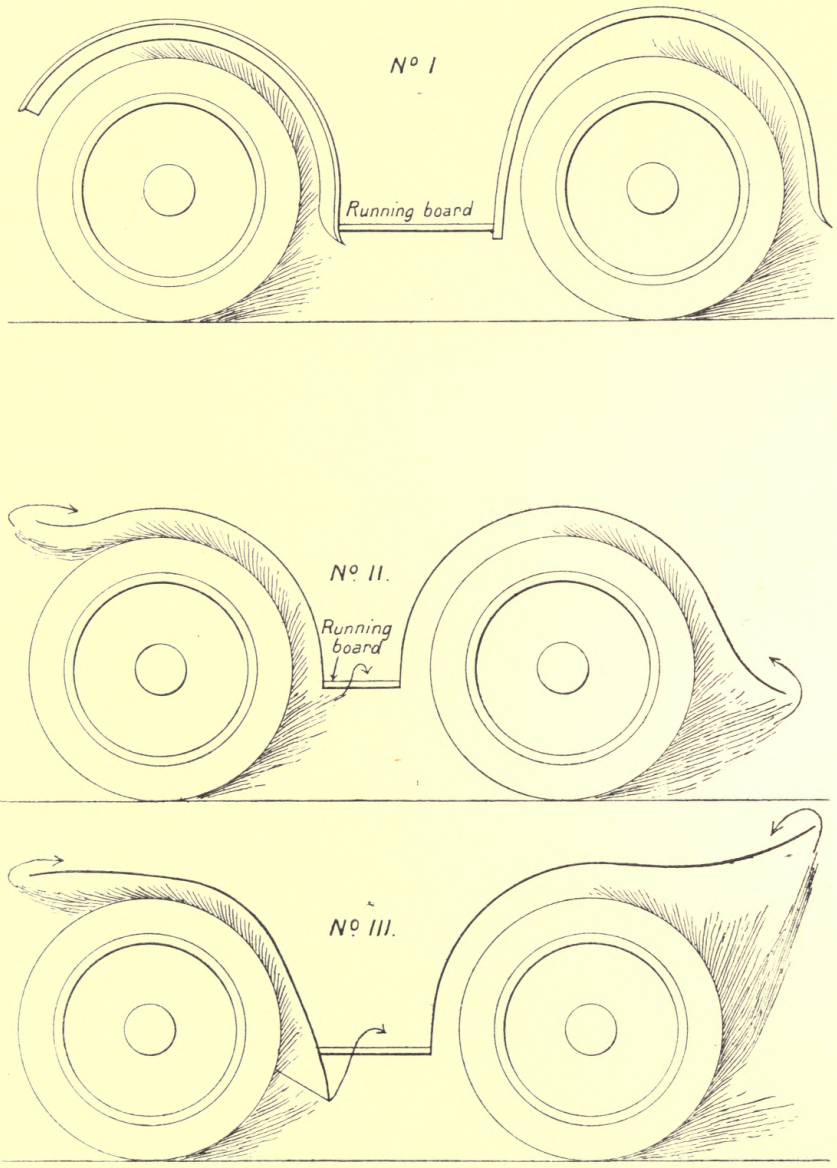
Taking the measurements for Wings.- A Sketch should be made & the sizes required marked on the same

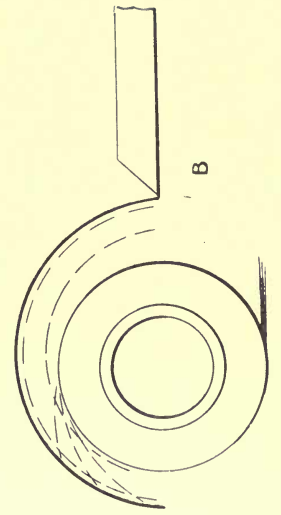


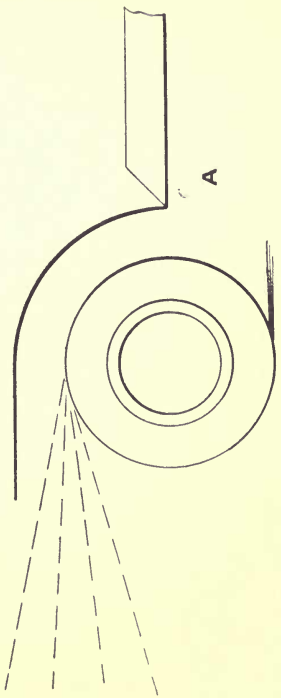
This view is required to shew the wheel clearance when turning. The inside extension enclosure is made hollowed or round & the valance should be in one piece with wing

PLATE XV.

PLATE XVI.







are curved in the uppermost portions, and have downward projecting flanges of substantial depth. They embrace, or should do, concentrically a greater circumferential portion of the tyre, and they are, or should be, fitted reasonably throughout their entire length closer to the wheel; or, in other words, the mud stream is restricted so near to its source that it is rendered almost harmless.

The ideal shape doubtless is that closely following the initial shape of the tyres, but this for several reasons would not be considered correct taste in harmonizing with other parts; moreover, circular mudguards have a heavy and ungainly appearance, and if made of too close a fit they very quickly choke up when the mud becomes pasty. The important point, then, is ample clearance and the embracing of the tyre over as large a part of its circumference as is practical. With side enclosures this is practically accomplished in Fig. 1, Plate XVI. Both back and front wings should be provided with deep flanges all the way round in order to keep the mud inside the guards. The rear guards, if fitted with deep inside flanges, keep the mud from splashing on the inside and over the back of car. If these flanges are neglected the mud splashes accumulate round the edges, and should there be a cross wind blowing, the sides get the full benefit.

In the two above sketches it can be seen that it is a mistake to carry the front of wing to a straight after following the circumference, for it results in the car being considerably spattered; but it should be brought over, as in B, reasonably close to the wheel, without in any way interfering with the play of the springs or lamp attachment. The forward end of mudguards should then always follow the line of wheel, and the best results are obtained by mudguards made on this principle, with inside enclosures, and deep outside flanges from pressed steel, all in one piece, and attached to chassis frame by portable fixing or socket stays.

CHAPTER XXI

WHEELS, AXLES, ETC.

WHEELS are used to convert a sliding motion of a sledge into a rolling motion of a cylinder (the wheel); thus friction is reduced. Those that are used for motor cars are known as the "Artillery" and "Wire" wheels, the latter being entirely of metal. It is a mistake to think that hand-made wheels are superior to machine-made. The machine-made wheels have generally been of inferior material, badly proportioned and built chiefly by the machinist, and not the practical wheeler. Where the wheeler knows his work, selects his material, understands and uses the best machines, then the mathematical accuracy of the machine is superior to the human hand.

While speaking of wheels I might mention a few words in reference to axles, although this does not interest the general motor body builder, except when sometimes to test the alignment, otherwise it comes little under his notice. The main points of a chassis are the engine, the gear box, and the back axle; all the rest are subordinate and appendages, necessary for successful and efficient locomotion. The front axles are mostly forged solid and bored to receive the swivel pin, which is well lubricated, the swivels having hardened steel bushes, and being supported by ball-bearings; in fact, most front axles of motor cars are of the pivoted type, the bed of axle being of stamped steel of various sections. The back axle or final drive: the transmission is now of a variety of forms, but the transmission by carden shaft or worm-gear drive is most common; the adoption of which have facilitated the business of the bodymaker enormously by allowing of an increased wheel base, consequently an improved type of body work.

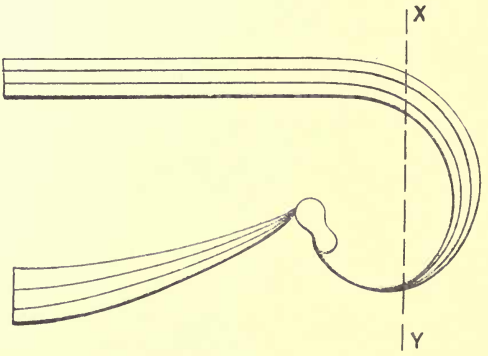
These axles, like all others, depend entirely on their superior quality in material and workmanship, and quality of case-hardening and fitting up, and the cost of a back axle in cars of similar H.P. may differ as much as £50, and only in the durability and continual sweetness of running can the real value and superiority be ascertained.

Springs.—All springs, whatever shape, are of the laminated form—a number of leaves or plates compassed, according to the height desired, secured in the centre by a rivet or bolt. Their form and construction, if sound, should have the power of making locomotion easy; and not merely this, they serve

to keep the wheels always pressing on the road without blows or jolting and convert what would be concussion into simple increased pressure. Mechanically they should receive and absorb by their quality of elasticity all shocks and vibrations before they reach the body and occupants. The shape, width and thickness of steel used, number of plates, have been, and will remain, to some extent, a matter of opinion, of which much diversity exists.

The lengths of motor-car springs vary from 38 in. to 48 in. for the hind springs and 30 in. to 40 in. for the front, the width of steel from $1\frac{1}{2}$ in. to $3\frac{1}{4}$ in., although wide springs are supposed to be better than narrow ones and less liable to twist. There is only one means of having a spring easy, doing its work, and at the same time resistant ; that is by making it very long. Motor springs should always have the ends of the top main plate finished with rolled eyes, welding for a lug weakens the steel. When a motor-car spring is fixed and the right deflection secured, the unloaded camber is of course equal to loaded camber, necessary to give sufficient axle clearance " plus " the deflection mentioned.

Many of the springs, especially the hind springs, have been found so weak that an additional plate has been added or the ends set up to give more resistance ; but frequently springs are injudiciously over-loaded. This can be noticed, apart from the loss of resiliency, by the ends of the plates " being off " their successor, and not giving the support and " nip " ; while when the springs are taken down and apart the plates are not of regular compass, the ends do not touch and the plates are not a proportional distance apart.



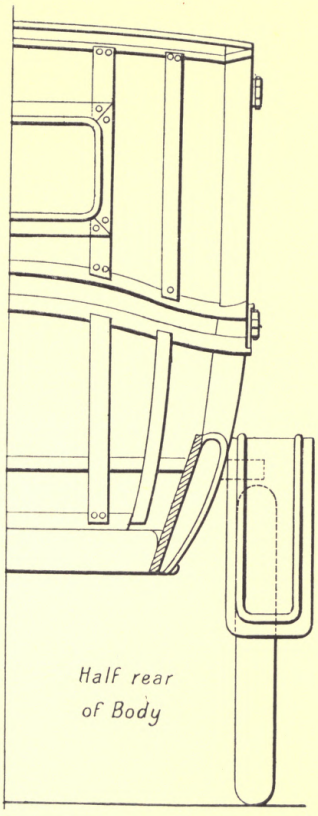
It must be understood that a spring must be elastic and at the same time have proper sustaining power, and in the form of spring now used there is one action only—that is, in a vertical direction—the ends of the spring being so attached as to allow of elongation by proper play, so that it can adapt itself to the varying conditions of load. Knowing the tendency of motor-car users to adapt all the many appliances for the reduction of power, increase of comfort and lessening of undue weight, it is difficult to understand the adoption of the top half elbow spring of the sketch, which

may at once be said to be faulty in application, unsound in principle, wrong in construction with a waste of material and labour and no extra comfort to be obtained. It is liable to set fast from X, Y, and does not possess the favourable free action that can be obtained from a uniform single curvature.

Iron (see also Chapter on "IRONWORK").—Cold short is iron that is naturally brittle or short, the fibre having by bad work been disintegrated, which frequently happens through the ironwork having been suddenly cooled by immersion in cold water, and not laid down red hot and allowed to cool gradually. It can be noticed in the fractures by its crystalline appearance. Ironwork that will be subjected to strains after fitting should be made red hot the last thing and allowed to cool, so that the molecules of the iron again assume their normal position before being tested by work. Much ironwork is spoilt by taking the heats too low, and much is burnt in the fire through over-heating; one iron is brittle when hot, the other brittle when cold.

The iron that fractures when hot is easily detected. Therefore when making a weld sand is not used as a flux, but to keep the iron from over-heating (burnt) whilst the other piece is getting to the same heat or fluid state for welding. There are no methods of testing the welding heat; it depends on the judgment of the experienced smith. Ironmasters speak of manufactured iron as red short and cold short, but neither of these are of much use to a coachsmith; he requires one which gains strength and ductility by repeated hammering or welding.

PLATE XVII.


Half rear
of Body

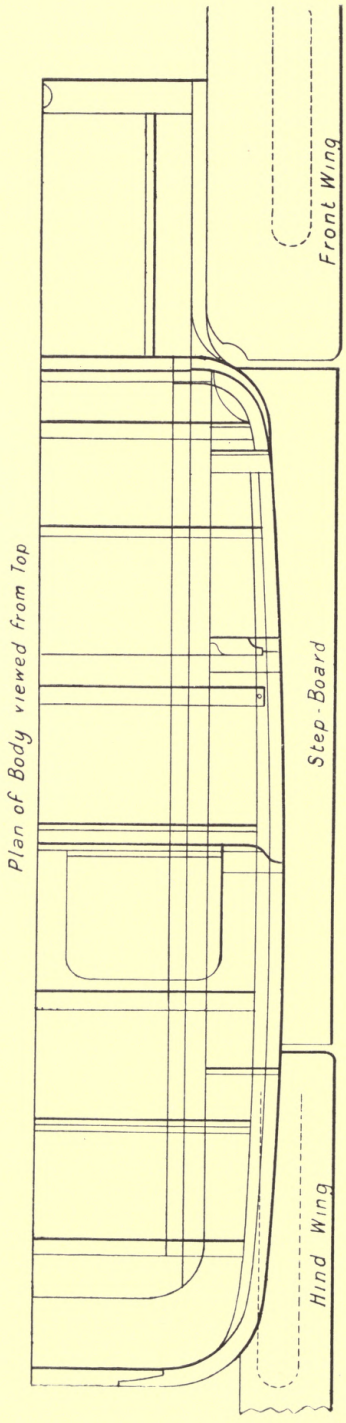
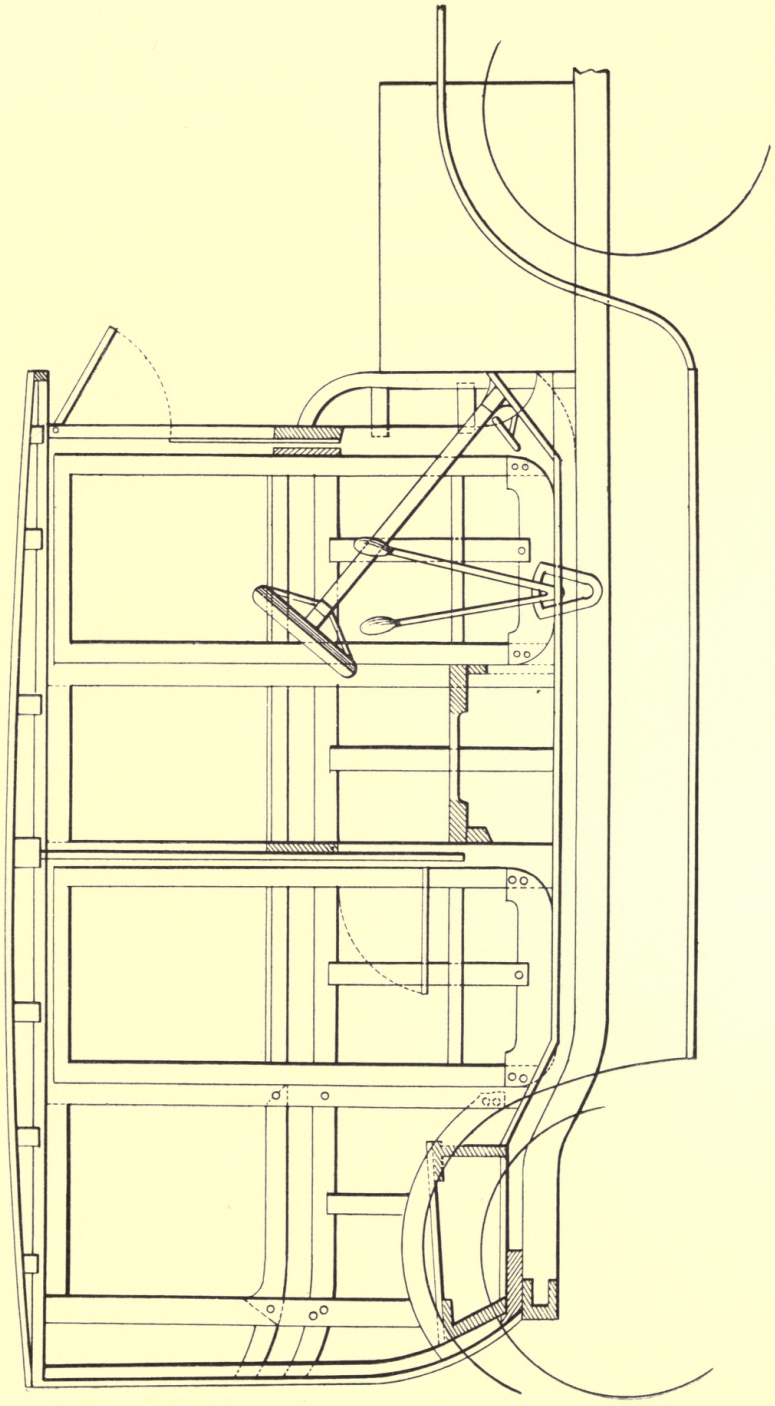

Front Wing
Plan of Body viewed from Top
Step-Board
Hind Wing

PLATE XVIII.



CHAPTER XXII

WORKING DRAWING OF LIMOUSINE

(*See* PLATES XVII AND XVIII)

THE working drawing of a limousine body gives an interesting study before passing on to the more modern types of body of this particular class (known now as the fully enclosed), though at the present time bodies of this description with birch or mahogany wells, rocker sides, or recessed bottom sides find a large amount of approval with motorists. The body is panelled throughout in aluminium, that is gauge twenty for the top panels or quarters, and eighteen for the bottom, but for cheapness metal can be used; but as to the question of weight the difference in the two materials is almost unperceivable if a lighter gauge is used.

The weight of aluinmium is 4·7 times that of mahogany and almost four times that of ash, and when lead-coated steel is used the weight is increased. Aluminium mouldings $\frac{3}{4}$ in. and $\frac{7}{8}$ in. will be used. In working aluminium by the bodymaker, even after his panels are fitted, and he is finally fixing, small and light cuts should be taken in drilling and fixing mouldings. In cutting a piece the cutting speed must be high, and for filing the aluminium, a single cut file will be found to last longer than the cross cut. The files can be cleaned by dipping them into a strong solution of caustic soda and washing. In the design it will be seen the hind seat is embodied in the design—a feature not so common as it was some time back —and the seat is a straight line. Thus the pitch is to be given to the cushion, but this is frequently got over by a false-framed seat, " chair caned," not panelled, fitted on wedge-shaped brackets. Thus ease is given to the occupants. The position of the folding seat is given. The cant is drawn on a principle by which many bodymakers work, viewing the side or turnunder of the body from the bottom instead of from the top. A point to be observed in the actual framing of the body is that the body standing pillars are kept $\frac{1}{8}$ in. thickness more than the door stuff. In making the drawing in the shop (full size) the usual procedure of the square line is followed: First, inserting the dash line; then following with the chassis line and wheel, etc.; and then with the square line of the belt rail, cant rail, seats, panels, etc. The design, though common and at one time much in favour, is not really a good one, for these reasons: there is too much overhang, and the length of quarters is disproportionate, while the varying depths of quarters should now, by common consent, run as nearly as possible in a line,

CHAPTER XXIII

CABRIOLET TWO-SEATER BODY

In designing this kind of body, you must take all the necessary dimensions as already mentioned, such as length of chassis, position of speed change levers and tank, etc. All these points being settled, construction lines must be drawn as described in the previous chapter on "*Framing*," then the outline of body put in, and the moulding drawn. All draughtsmen should show in outline the end view, as when drawn it makes the width clear at given points.

Patterns required will be: (1) The corner pillar and bottom side; (2) the elbow; (3) the back-rail, and—at least—the three side sweeps. It will be seen from the cant board that No. 12 may probably work in for the sweep on the elbow line, the others working into a fainter curve, because on the bottom we have it running in very nearly straight, the bottom side from corner pillar downwards being screwed to the runners. The hind boot-sides to form the tool case are screwed to the inside of pillars, a wedge piece being fitted in the vacancy between the boot-sides and corner pillar.

Cant board.—All that is necessary for this body is shown. A short pine board is placed against the side elevation of body, and the following points marked off and squared—

1st. The length of body.

2nd. The width of doors.

3rd. Lengths of hind quarter, and position of hind bar, the back-rail and the top of sham door, then the front edge of seat rail. You will now draw in your side-sweep on the elbow line, the thickness of same being $1\frac{3}{8}$ in., then draw in your corner pillar and bottom sides, being careful to let the curved lines pass through the points marked off to bring the body to the right widths. For instance, if the body is 4 ft. 4 in. on the widest part, our chassis (35 in. wide at that point) will be $8\frac{1}{2}$ in. outside; from that point inwards you will mark the size of framing, and if there is a cross-bar it will run into square with the chassis, but giving a bevelled shoulder.

CHAPTER XXIV

TORPEDO MOTOR BODIES

(*See* PLATES XIX AND XX)

THE construction of the framework of torpedo bodies (Plate XIX), so far as joint work is concerned, is extremely simple and only needs to be well done, white-leaded and screwed. The chief point to consider is that the body drops on the chassis ; thus the measurements must be accurately taken. Assuming that the change speed and brake levers will come inside the body, they will to some extent govern the width of the front seat, etc.

All seats are now made independently and can be arranged to suit steering. In cleaning off the body care must be taken that no batten is high on any edge, causing a bulge in the panel. The panels must fit dead, and be screwed or pinned in position. In arranging the depth of back seat, care should be taken to keep it such a width that when the occupants are using same the heels of the shoes are not in contact with the bevelled piece of the chassis. The framework may be kept very light, the ash framing, $1\frac{1}{4}$ in. and $1\frac{3}{4}$ in. thick, endeavouring to keep the body in framework about 1 cwt. and when complete with panels and mouldings, $1\frac{1}{2}$ cwt. ; there is no need for the framing to be heavy, only where necessary to carry the fittings, especially with steel panels. The boards for bottom to be fitted loose. The bottom framing is frequently made with only one wide cross bar at the back, if a second or third, they must be arranged so that they in no way interfere with getting at the gear-box, differential, or any other part of the chassis. Particulars of these can be taken from the Engineer's blue print or the chassis itself.

PLATE XIX.

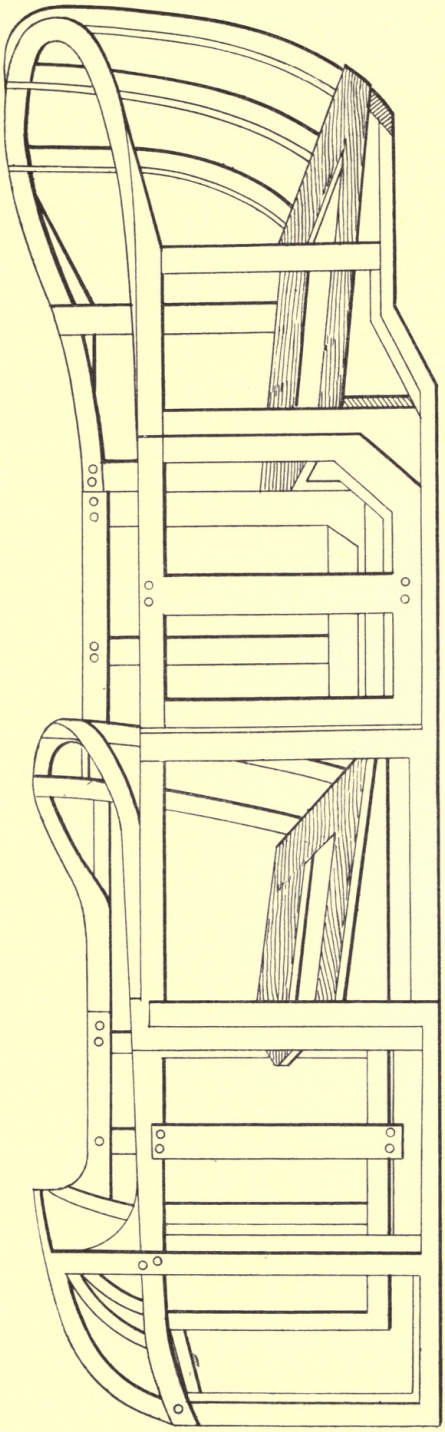
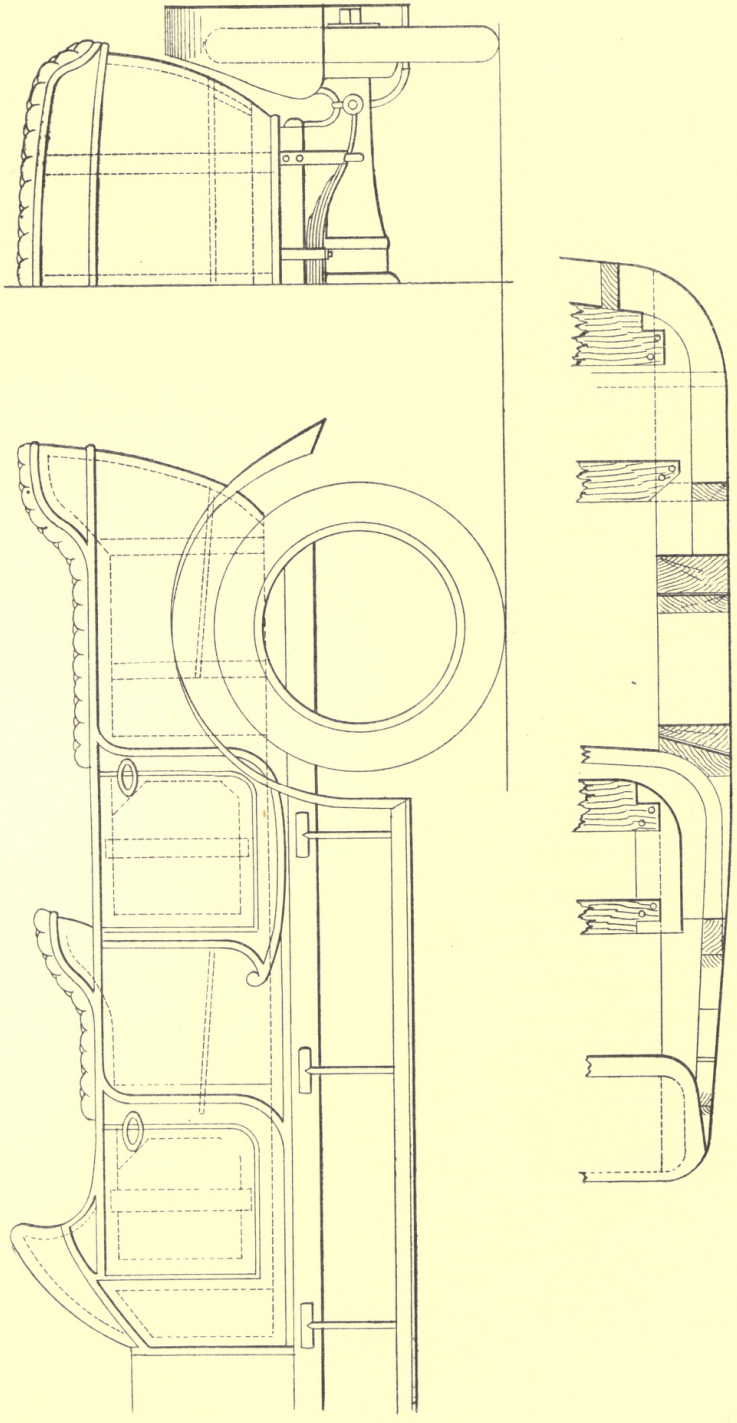


PLATE XX.



CHAPTER XXV

CABRIOLET HOOD

It is easily apparent to the bodymaker that exactitude is necessary in the marking in, setting out, also letting in the various hinges and joints, if the hood is to work sweetly, stand square and true, and when the hood is locked all joints must be up square, with the necessary clearance for paint and varnish, and also it must work freely in closing up " concertina " fashion. This particular hood is probably one of the simplest, and the various parts are enumerated in Plates XXI to XXVI. In the place of the ordinary pillar hinge, we have a specially made joint, keeping the centre low, the cranked elbow that carries the pillar joint being made out of $\frac{9}{16}$ in. round, and being exposed, this fitting is " brassed " all over.

The top cant rail hinge is placed in the ordinary manner—with stout $1\frac{1}{4}$ in. brass butts let in, and the same to the rear stretcher bar (No. 2, Plate XXII). These front bars are made out of birch or mahogany. The ordinary $\frac{1}{2}$ in. knuckle joints are to be used, and the hinging of the extremity of each end with its flaps is seen. Nos. 3, 4, and 5 are the ordinary hoopsticks bent with a corner at the back to welt the leather. Carefully let in the hinges, fixing the same temporarily with small screws, testing that all work is square to the joints both upwards and sideways, likewise when the hood is folded. See that the cant rails are also quite square with the pillars when all is extended. This is essential to a good job.

We have outside head joints, but to make a clean job the pillar tops and the under sides of the top half have brass " polished " plates fixed. In this hood the leather or other covering is not fixed to the cant rail along the hoopsticks, but brought over the rail and welted. The front light pillars are cut off and hinged to fold as usual and connected with the cant rail with a pillar fastener, a drop or folding light or screen being fitted to work behind driver's seat.

A Sectional Drawing of a Cabriolet Body showing Folding Hood and Fittings.—It will be seen (Plate XXII) that the hind door pillar top is hinged by an off-set lug, pivoted and connected to a lug on body, both to take the weight of the parts, and to assist in the lifting and opening out of the hood. The usual telescopic spring is used, the upper end, jointed to top part of pillar, and the lower end to the body, behind the hinge. The

PLATE XXI.

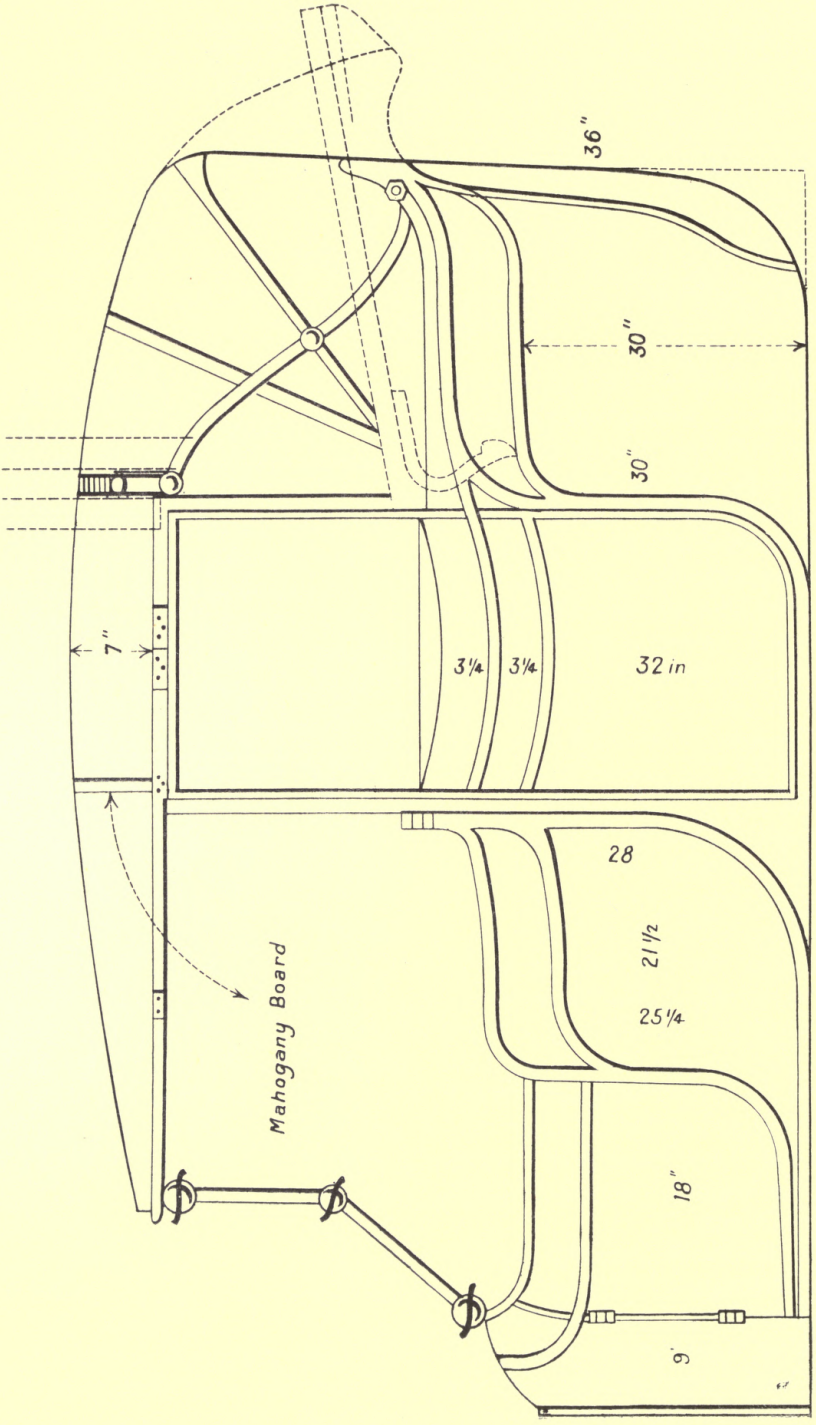
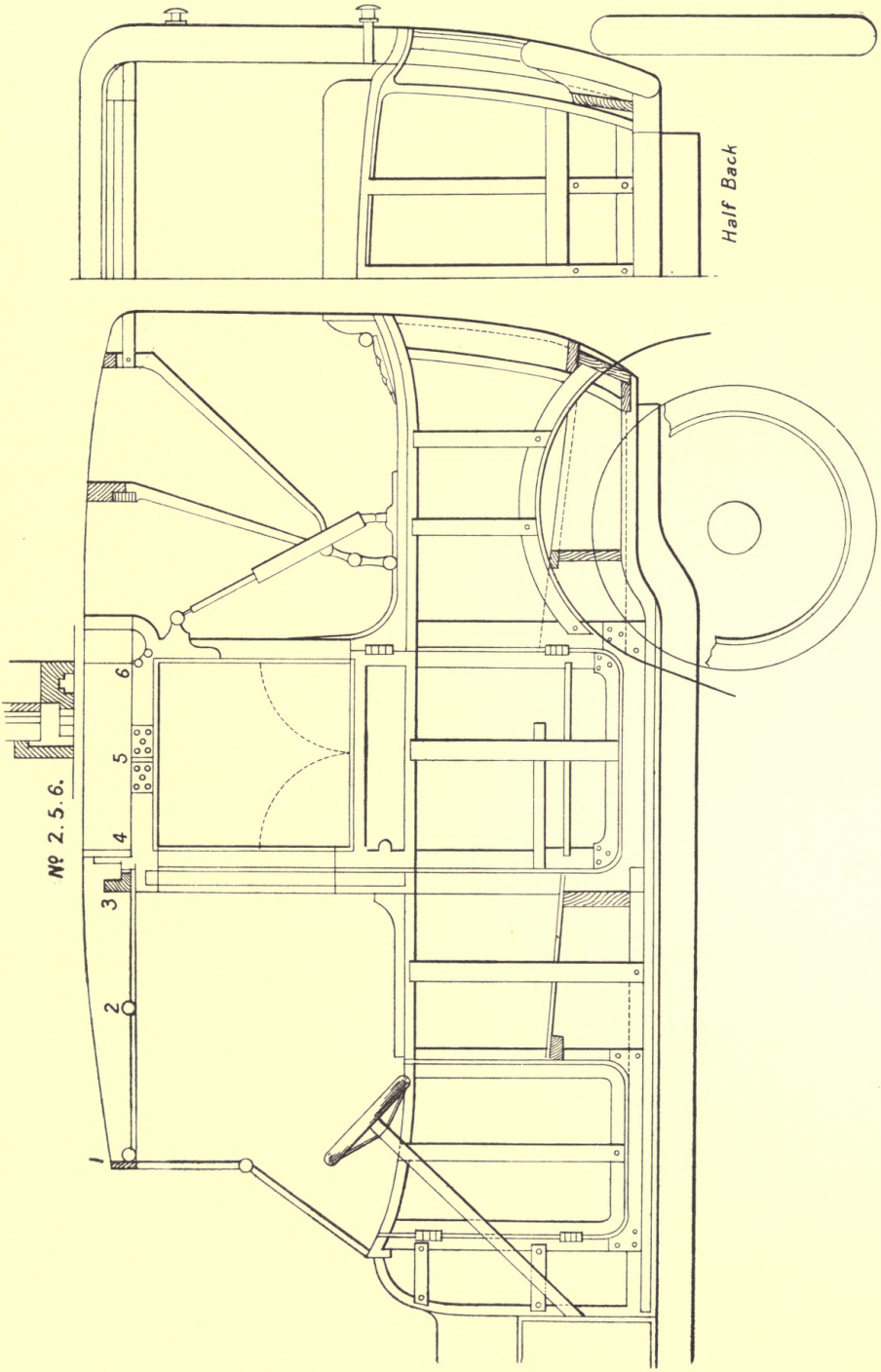


PLATE XXII.



usual neck plates carry the hoopsticks. The cant rail has its rear end abutting against the pillar, while in front it rests on the inwardly folding front pillars. The rail is connected to the hind standing pillar, by means of two links, which are arranged substantially, and horizontally, and jointed to the side of the cant rail at a point considerably forward, while the other end is arranged nearly vertical and has its upper extremity jointed to the inner end of the cant rail. To ensure a simultaneous folding of the parts a normally vertically disposed radius link is employed on the pillar, the upper part being slotted and jointed at about the middle of the link by a pin, while its lower end is fixed to the pillar on which the pillar top rests. To fold the hood, the cant rails are raised and folded back, the link hinges causing the rear end of the cant rail to leave the face of the pillar, and to turn into a pane parallel thereto, while the lower link hinge causes the pillar to fold down simultaneously. When the hood is fully collapsed, all the parts should be one upon the other, with the usual clearance. To open out the hood the cant rails are raised from their position, assisted by the action of the springs, when the link hinges cause the parts to assume automatically the position shown in the elevation of the drawing (Plate XXIV).

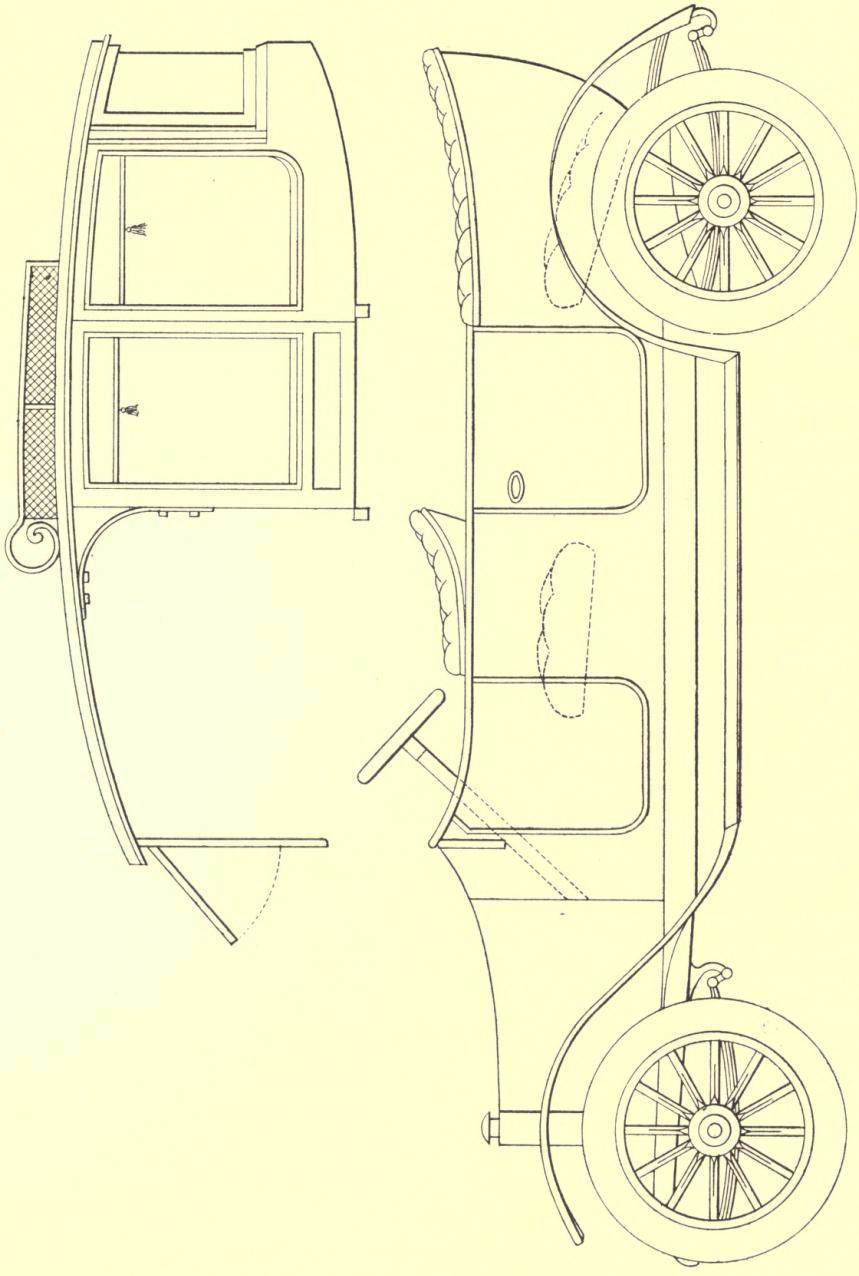
1. The pillar joints.
2. The patent cant rail link hinges.
3. The barrel telescopic springs.
4. Head props.
5. The straight joint ends.
6. The knuckle joints.
7. Elbow prop and stump joint.
8. Front pillar catches.
9. Front pillar hinges.
10. The front joint ends with flap for extension canopy rail.
11. $\frac{5}{8}$ in. knuckle joint.
12. The joint end with flap for front top rail.

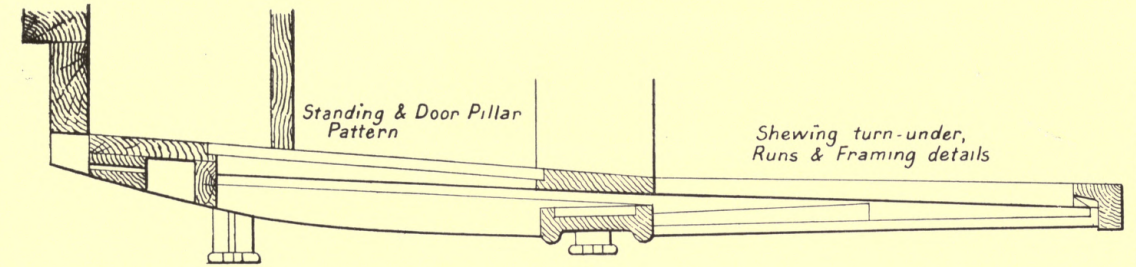
CHAPTER XXVI

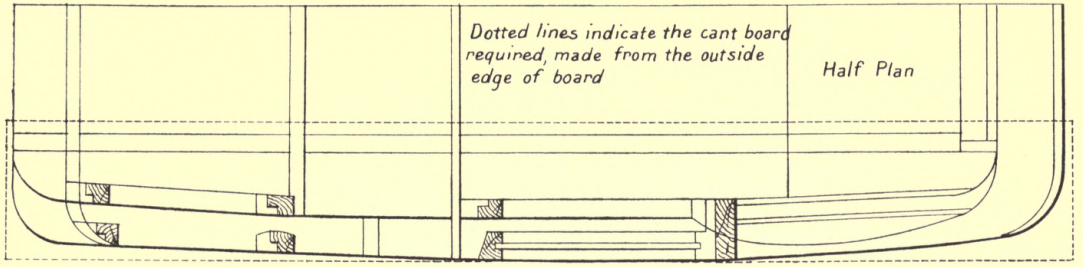
CONVERTIBLE FLUSH-SIDED BODY WITH DETACHABLE LIMOUSINE TOP

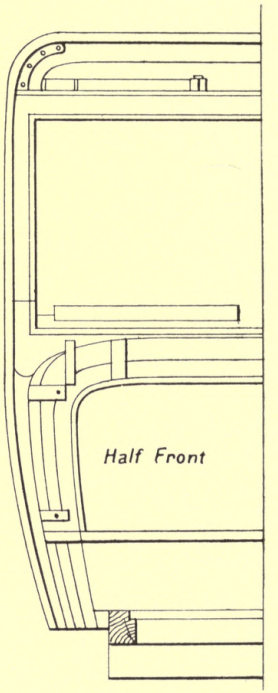
THE detachable top requires the greatest care and attention to ensure that the lower framework of top exactly fits and coincides with the framework of body on which it rests, the trimming being kept back about 1 in. so that a ledge is formed. Again, the pillar of doors with its rebates must watch the body door, so that glasses may drop freely when top is on, a capping piece fitting on the recess, or if not to drop it may be hinged to top to fold downwards in frame when not required. The front can be made in the folding wind screen pattern or with frames to slide on bottom rail of top, the sides as a rule are fixed—not necessarily so, they can be made to fold in two, hinged in the centre, thus ventilating the top. The whole of the body is fitted with sheet metal steel panel, gauge 20 for bottom where beaten, and 22 for flat and top panels. Apart from the framing and panelling of body, the fit and ease of the detachable top is of paramount importance, and has been the cause of bringing convertible cars into much disfavour. Without going into details of the many and varied methods of fixing the top, I will give for simplicity and ease the following way of securing it rigidly with the set-screw and boss ; if neatly made outside with the front and door inside it proves a satisfactory job. The bottom framing of top may be rebated if preferred, or quite flat with a $\frac{3}{4}$ in. or $\frac{7}{8}$ in. brass or aluminium door plating fixing all round ; this makes a neat and water-tight finish as in Plate XXVII. The top is generally removed by the aid of a block and pulley, and the position of the forged eyes must be found after the top is finally completed, painted and trimmed with glasses and everything. See that the top is balanced, hangs level when pulled up off the body, so that it may be easily dropped on and taken off by one person. The leverage of front and screen has a tendency to tilt the top off, therefore the exact balancing point must be found. The forged eyes are at each corner.

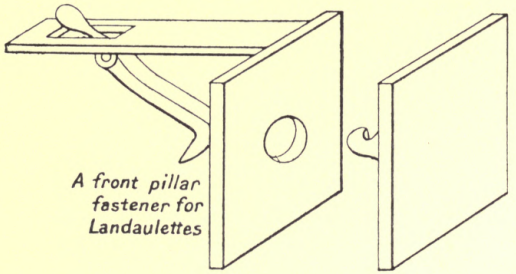
PLATE XXIII.




Standing & Door Pillar Pattern
Shewing turn-under, Runs & Framing details


Dotted lines indicate the cant board required, made from the outside edge of board
Half Plan


Half Front


A front pillar fastener for Landaulettes

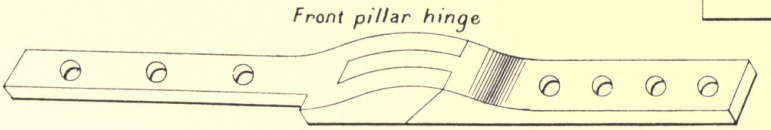

Front pillar hinge

PLATE XXIV.

PLATE XXV.

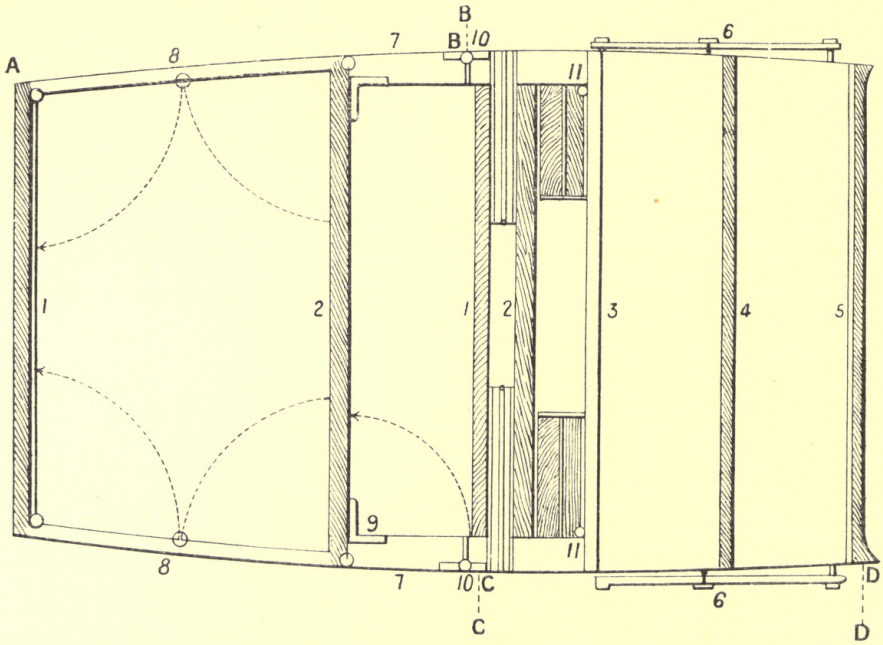


PLATE XXVI.

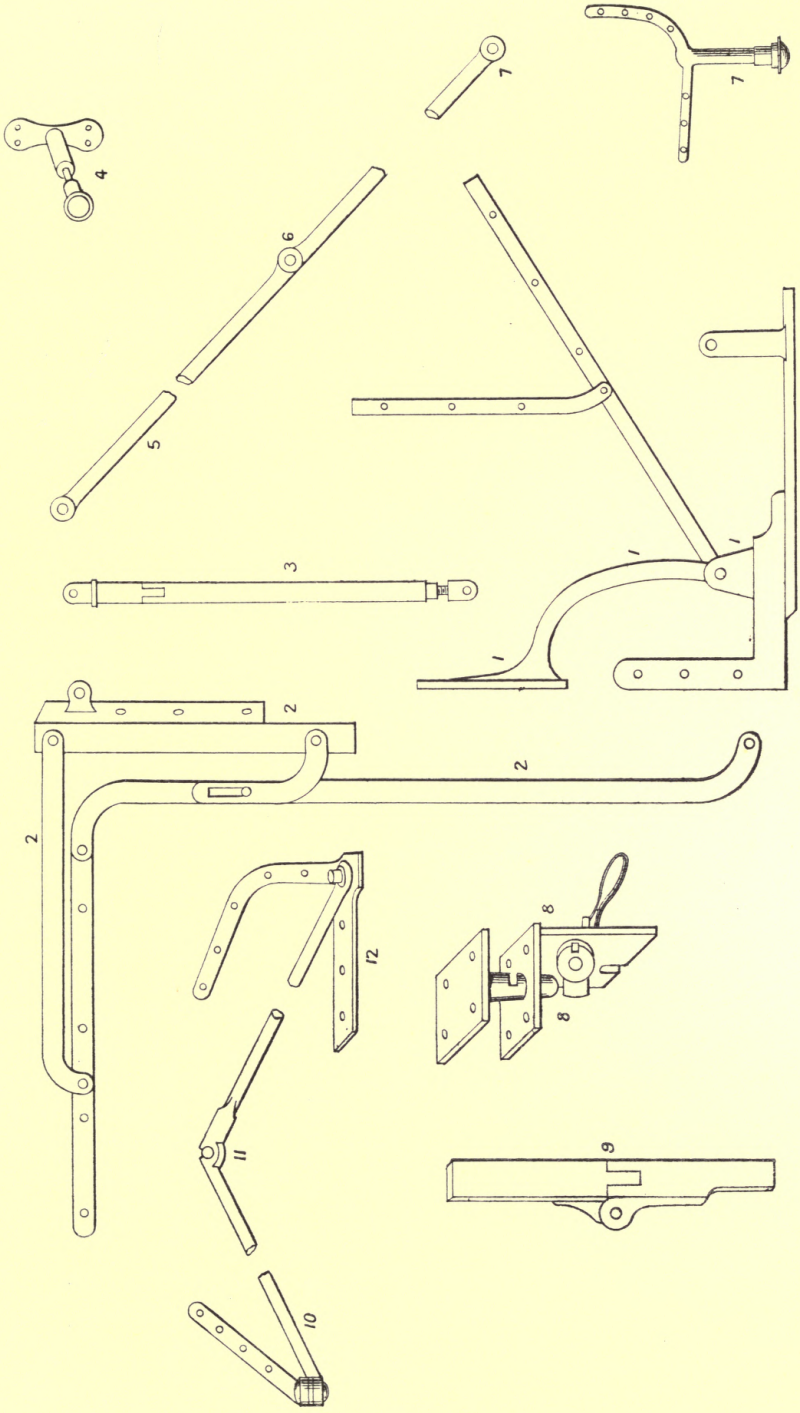
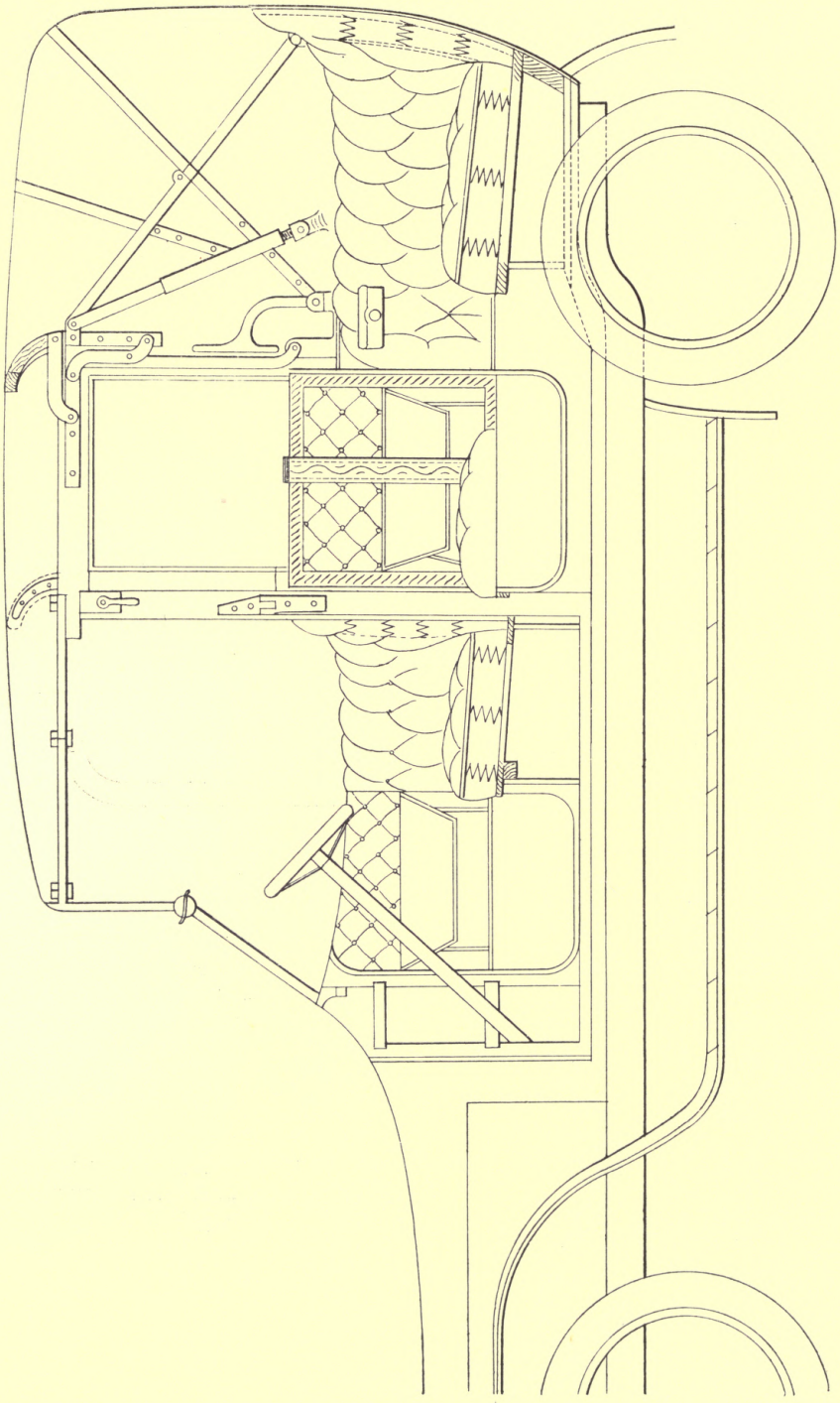


PLATE XXVII.



CHAPTER XXVII

WORKING DRAWING OF D-FRONT LANDAULETTE WITH CANT

THE accompanying various plan drawings (Plates XXVIII and XXIX) should be a key and assistance to the reader in making up the working cant board from a bodymaker's point of view. The pillar pattern is to be made up for single runs ; the door itself is a full one, but the middle rail is to be in two light rails, panelled, with mahogany in between. (Plate XXX.) The full-size drawing is made in the factory, and the pillar pattern provided with the necessary square lines firmly marked on. The bodymaker will take his " cant board " of pine—with edge " shot " true and the line of chassis marked on—and mark off the necessary square lines of body—dash, doors, pillars, lights, cant rails, length of quarter, depth of D-front, the position of seat and other framing rails, squaring them across the body.

This completed, he will now mark on the seat lines his length of seat ; these are fixed points for his interior widths. In this instance we have 3 ft. 4 in. on front, 4 ft. 2 in. on hind seat. Thus if the chassis is $32\frac{1}{2}$ in., deduct $32\frac{1}{2}$ in. from 50 in. $= 17\frac{1}{2}$ in., giving one side of $8\frac{3}{4}$. Mark this outside the chassis line at seat rail on this line. Beyond this we now set off the thickness of one pillar (if the seat is against the pillar) ; if not, carry the line forward to the pillar, and set off the distance, say $2\frac{3}{8}$ in. You will now mark the width on elbow line at back and front and draw in your base line or side sweep. You will then proceed to the front and set off the length on front seat, thickness of framing, width of front at standing pillar, and at hinge pillar of front door, and draw in the side sweep.

All the sweeps of the body below the elbow are of a graduated character owing to the turnunder. The thickness of framing timbers is marked inwards from the swept lines. The hinge pin from which the bevel is struck stands $\frac{5}{8}$ in. from side of body.

PLATE XXVIII.

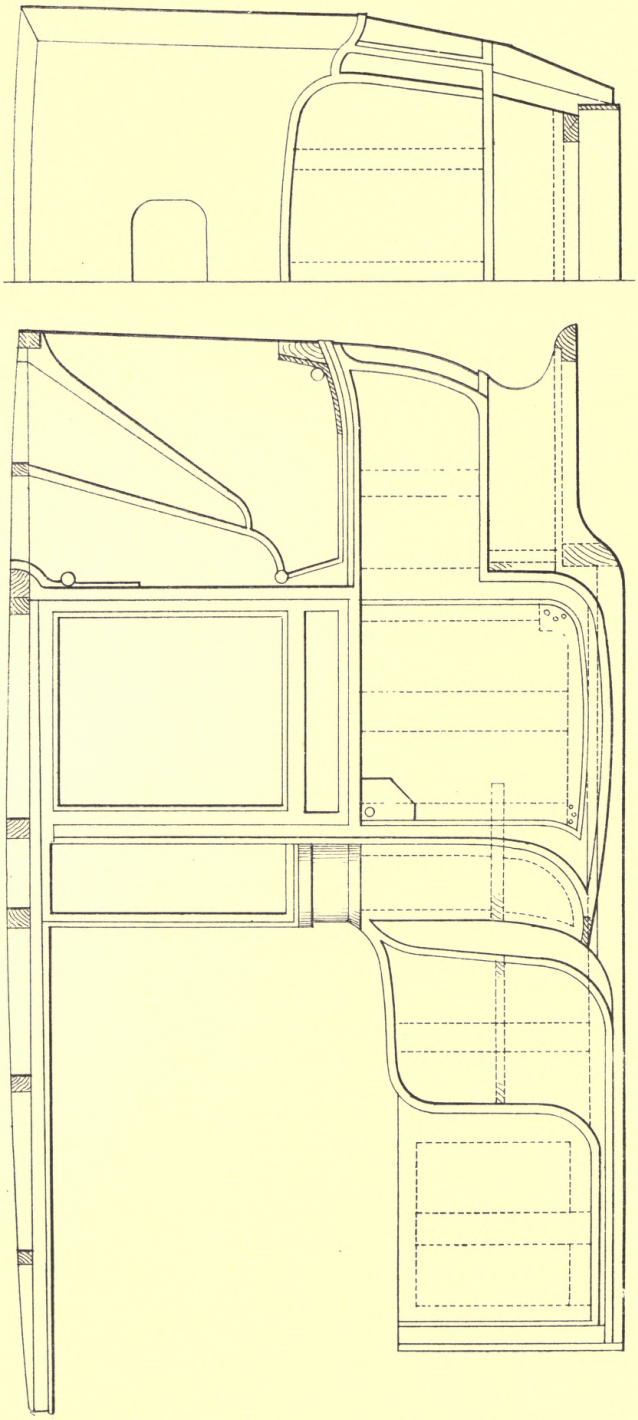


PLATE XXIX.

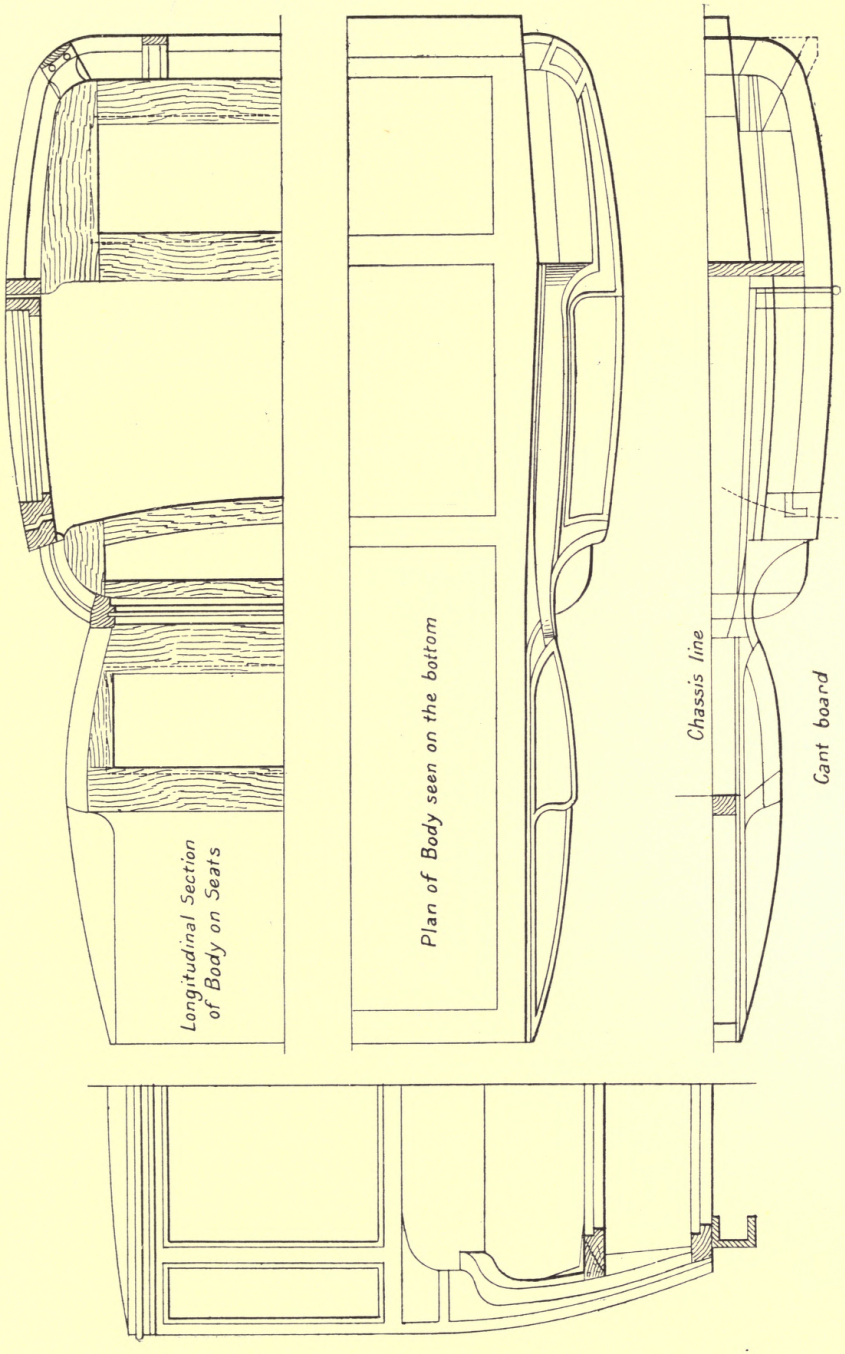
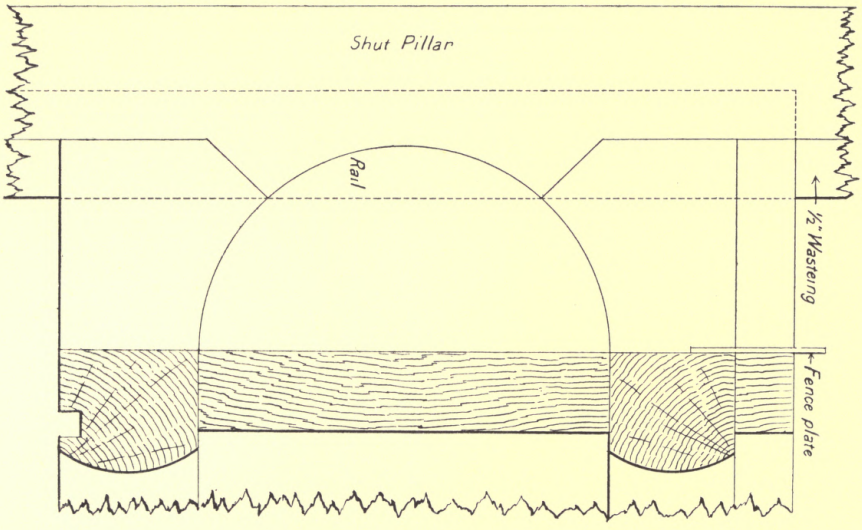

Longitudinal Section of Body on Seats
Plan of Body seen on the bottom
Chassis line
Cant board

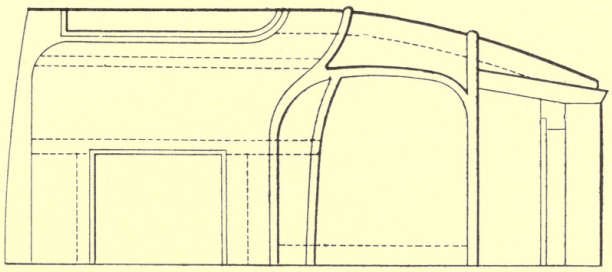
PLATE XXX.

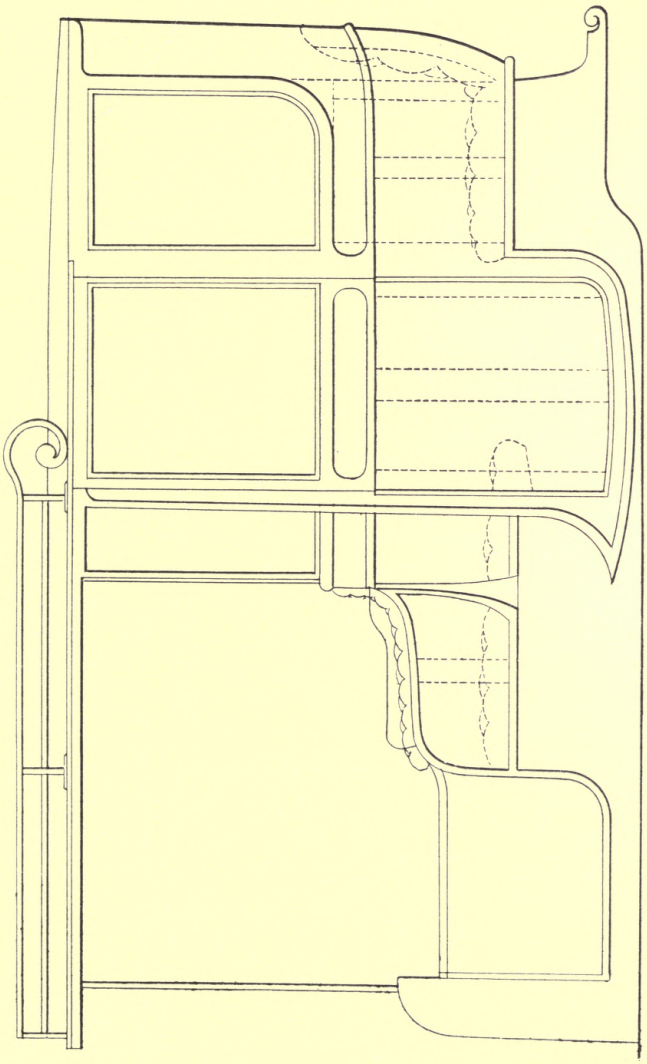


MIDDLE DOOR RAIL.

Method of framing the door rail with the moulding swept at extremities. The rail being in the solid, out of $1\frac{1}{4}''$ *or* $1\frac{1}{2}''$ *mahogany, makes a satisfactory job, stumped tenon into pillar and screwed from outside. Rail grooved for wood panel in this instance.*

PLATE XXXI.





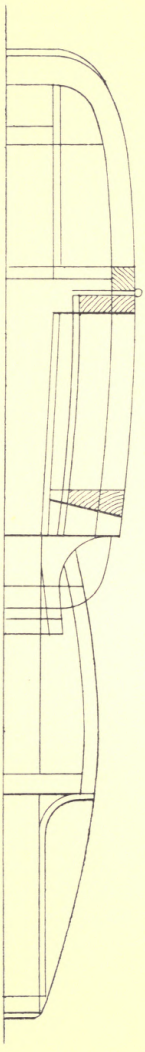
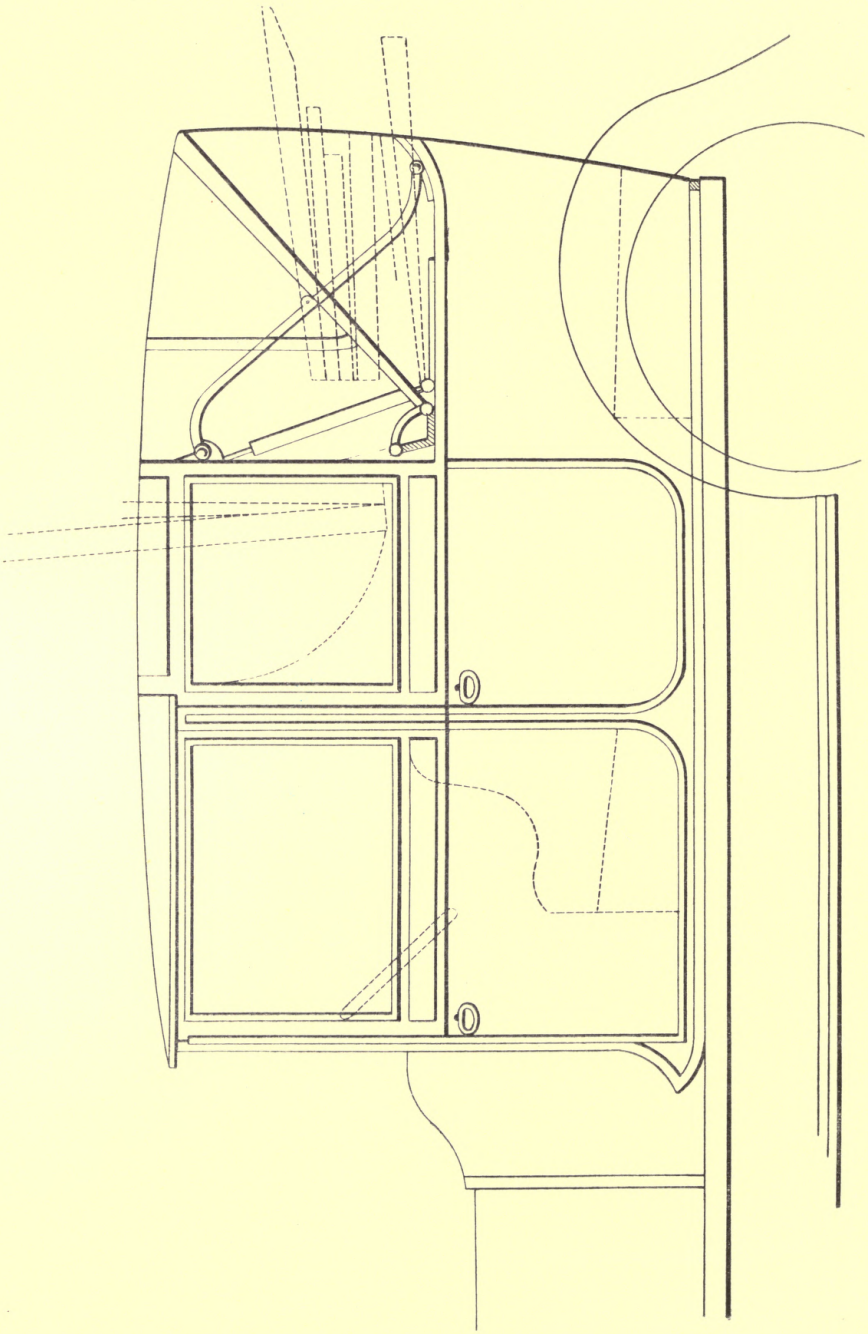


PLATE XXXII.



CHAPTER XXVIII

ENCLOSED CABRIOLET

THIS body (Plate XXXII) was designed for a 38 H.P. Daimler, four cylinders, and was built with two doors on the near side and one on the offside. The front seat is built in one, but trimming pieces are fitted to form bucket seats. The centre pillar folds and drops on back of front seat; the front pillar remains standing, but the top rail is to be made to go back with the head. The top rail is fixed with "Beatson" cabriolet screen fittings which allow the top half of screen to swing. The back portion of cant rail drops downwards, the front portion folding back over it. The centre stick moves on the irons as shown, which are long enough to push it out of the way. The back pillars and hoopsticks are fixed altogether, while the usual glass-frame carriers are to be used. The ordinary cabriolet neck joints can be used instead of those shown.

The advantages of this design are that the moving centre hoopstick takes the leather well out of the way, besides keeping it from "sagging" when the head is closed.

CHAPTER XXIX

WORKING DRAWING OF 16-20 H.P. WOLSELEY FLUSH-SIDED BODY

(*See* PLATE XXXVII)

Wheel base, 10 ft. 1 in.; Track, 4 ft. 4½ in.; Body space, 8 ft. 6 in.; Dash to centre of hind wheel, 7 ft. 5 in.; Flush panels all round.

FULL-size drawing should be first made by putting in the " plumb " line of dash, on which mark the height of chassis, square with which draw in chassis line, setting off body space and rise of hind part and the position of the hind wheel. Following this you will square with the chassis, set off the various width of body seen on the side view, depth of scuttle dash and width of quarters and doors, drawing the square lines. After this the seats must be marked in, above that the required head room above seat, bearing in mind that the front seat is dependent on the steering with the clearance, and that we intend to fit a folding tip-up seat; all the considerations that govern these and the hind seat have been given in the " Measurements of Seats." These details determined, you can design your body to embrace these measurements, introducing the curves and lines to taste. This accomplished, a back view (if not in detail) should be drawn to show the body in relation to the wheel and track.

We have now determined the widths on seats at hind part between panels (4 ft. 3 in.), which with width of chassis governs the amount of turnunder, and enables us to make the pillar pattern up as shown in the drawing, and further gives (with the side sweep required on body) the necessary particulars for the cant board. The cant board should now be made by placing the narrow pine board against the side elevation drawing, and setting off all the points of length of body, doors, quarters, dash and then squaring the same over; the line of chassis should be put in, after which the length across the body on seat must be shown. It is well now to complete your doorways in the plan, and the substance required to be marked on the cant can all be taken from the pillar pattern. The sweep on the side of the body is drawn in, also the elbow and the corners are struck in, and other details, following on in the order shown in plan drawing.

PLATE XXXIII.

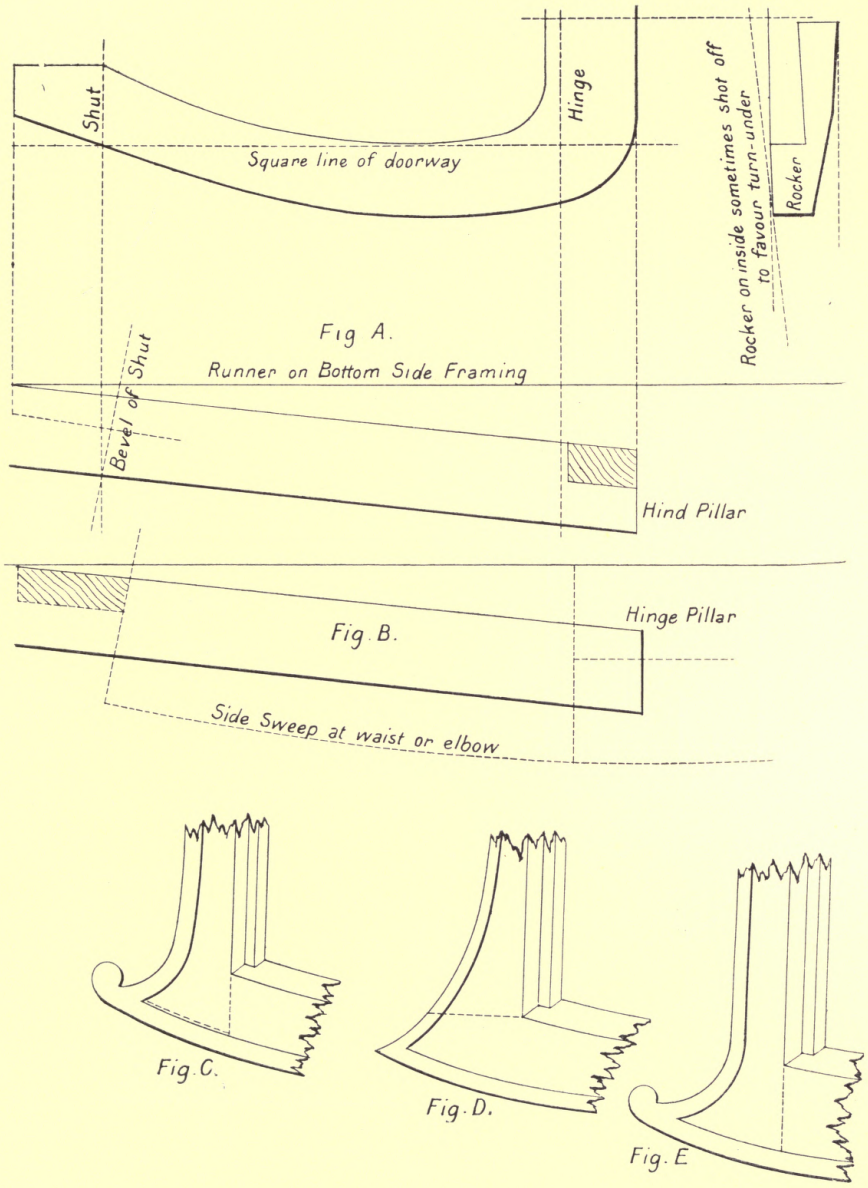


PLATE XXXIV.

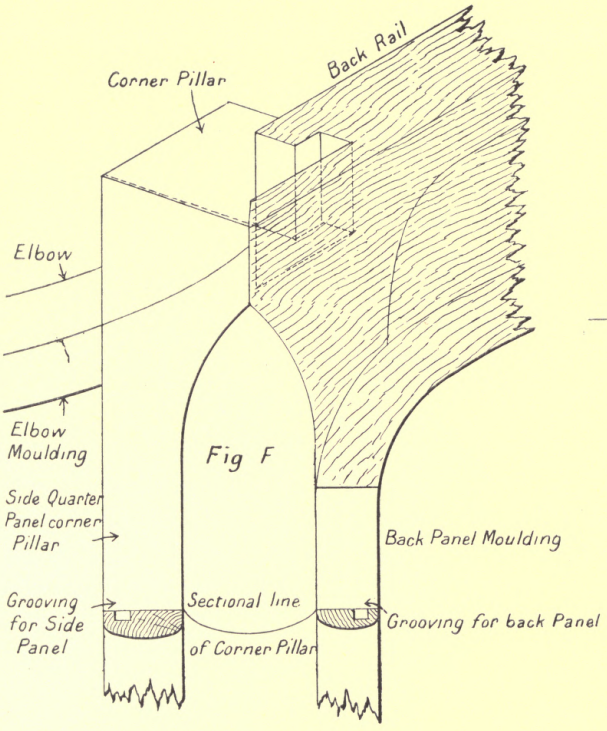


Fig F

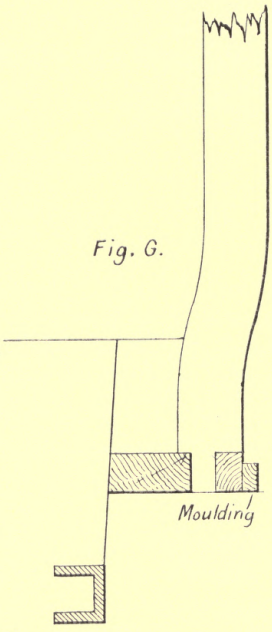


Fig. G.

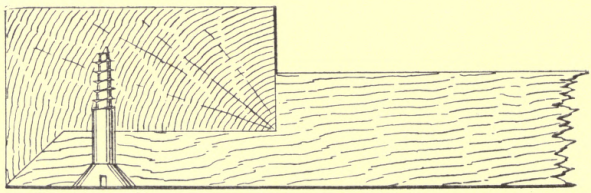
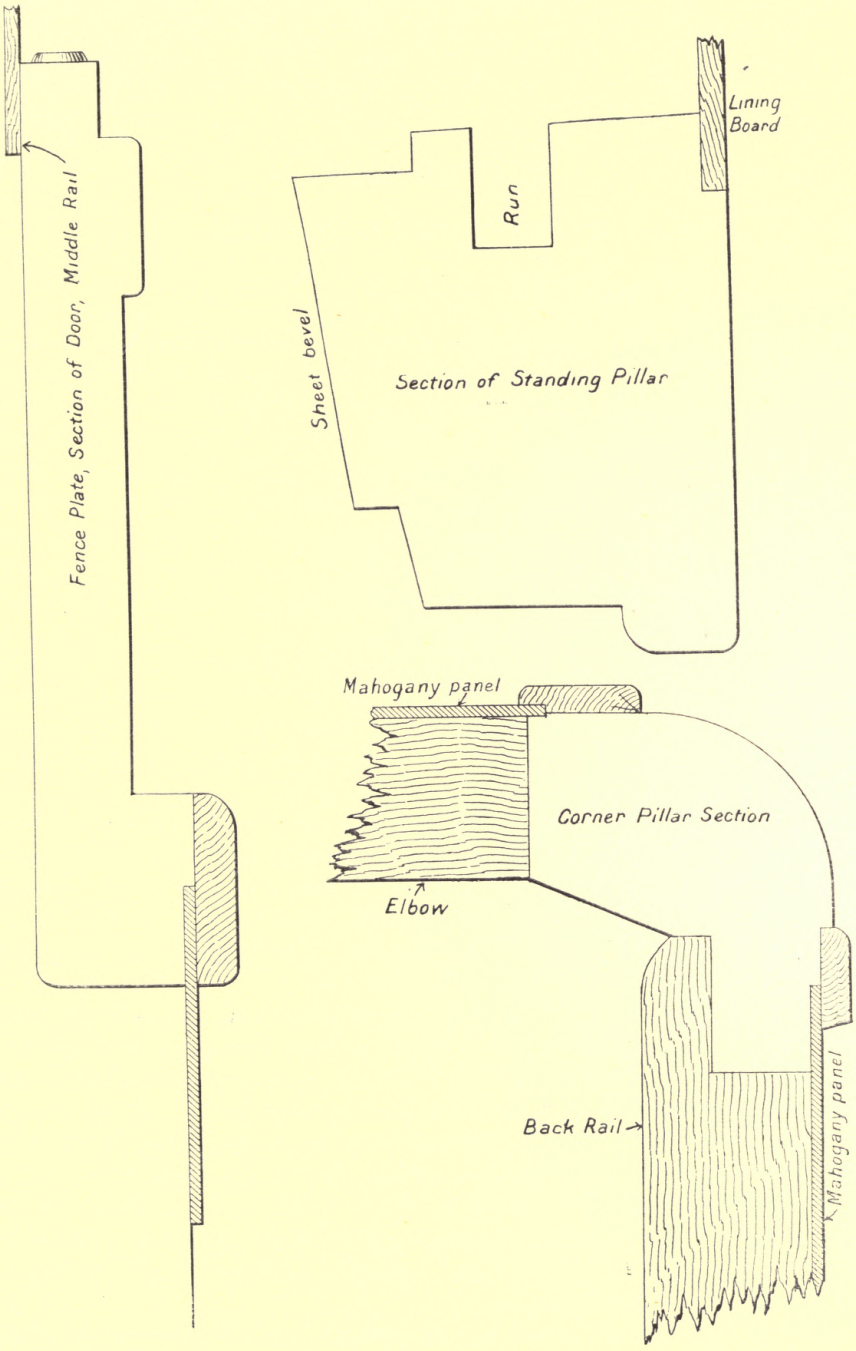


Fig H

PLATE XXXV


Fence Plate, Section of Door, Middle Rail
Lining Board
Run
Sheet bevel
Section of Standing Pillar
Mahogany panel
Corner Pillar Section
Elbow
Back Rail
Mahogany panel

CHAPTER XXX

D-FRONT LIGHT LIMOUSINE

(*See* PLATES XXXI AND XXXIII)

THIS is a design of quite a modern type of up-to-date town motor carriage. The full-size sectional sketch of the door shut pillar and the sketch plan of cant will supply details for making the body, which it will be seen is entirely of the round corner pattern with full large light in the back panel. It will be seen here that the body is made independent of the front seat, and that we have a boot side, to which the rockers are screwed, and this should always be cut out of good hard wood, such as birch, or for preference mahogany. The pillars of body are cut out of $3\frac{1}{2}$ in. and 4 in. plank, and are tenoned into the cant rail, while the rockers are half lapped on to the pillar and screwed from the inside.

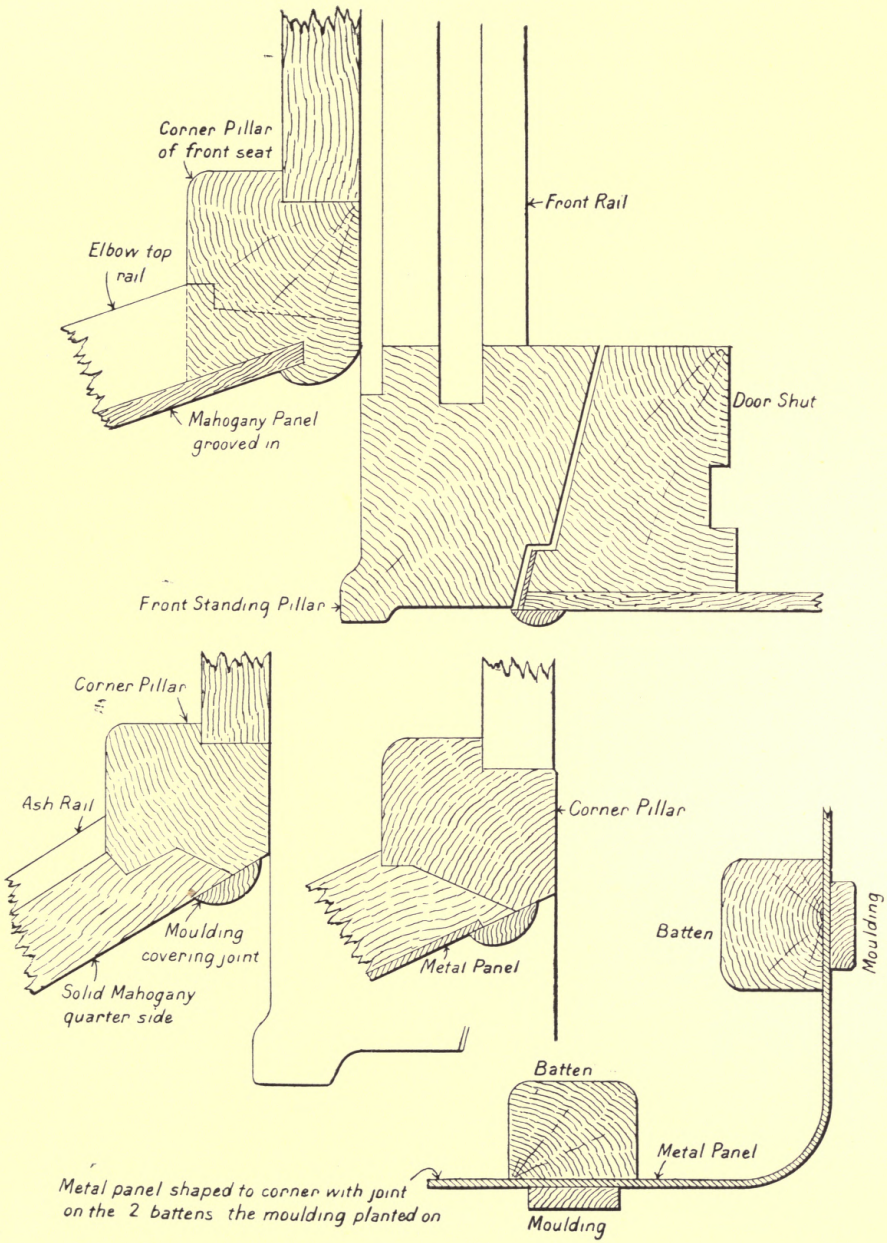
These are then screwed to the rocker, and in framing great care must be exercised that the body is square in the doorway, at the square line on rocker, also at the elbow and at the cant rail. The door rebates on these pillars—in fact, all limousines I recommend to be $1\frac{1}{8}$ in. wide and $\frac{3}{8}$ in. deep, which will give a good bearing for the door when shut.

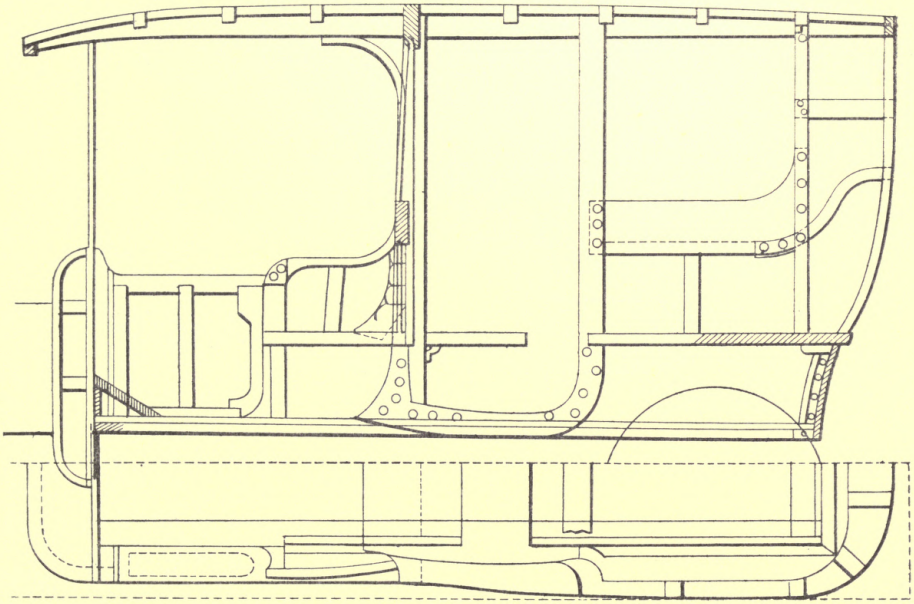
The rocker will take $3\frac{1}{2}$ in. timber cut to the shape got from the patterns made from the drawing, and the patterns necessary will be door and standing pillars, rocker, corner pillar, turnunder, side-sweep, cant rail, canopy front, elbow, door bottom, front standing pillar, bent D-corners, hoopsticks, back rail and front light pillar pattern. With these and the necessary square lines the body can be constructed.

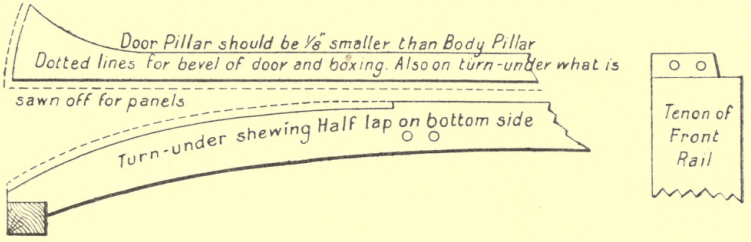
The framing of the rocker is of great importance, for the difficulty here experienced is that the body not only has to frame a swept piece of framing, but is at the same time contracted, while the main supports of body—the pillars—are connected with various joints, their position being always square; frequently (as in the front) they curve round to favour the side-sweep, or to line with the contraction and at the same time accord with the turnunder. The sketch B (Plate XXXIII) differs from that of sketch A in this respect, that the hind pillar is not gauged in a line with rocker, but square with line of the hinge pillar—dropped in, so to speak—this being the general practice.

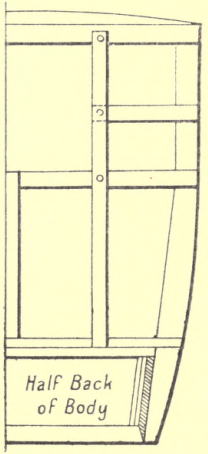
As to the position of the rocker in its relationship to the side-sweep in plan, it must be realized that in motor work the door shuts or closes on top of

PLATE XXXVI.


Corner Pillar of front seat
Front Rail
Elbow top rail
Mahogany Panel grooved in
Door Shut
Front Standing Pillar
Corner Pillar
Ash Rail
Moulding covering joint
Solid Mahogany quarter side
Corner Pillar
Metal Panel
Batten
Moulding
Batten
Metal Panel
Metal panel shaped to corner with joint on the 2 battens the moulding planted on
Moulding







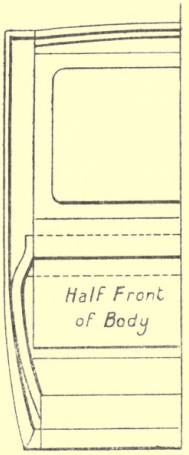
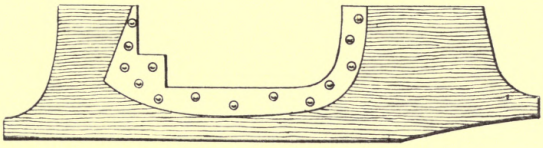


PLATE XXXVII.

rocker inside, while in carriages the door is, as a rule, carried through, and the bodies have what is known as a cut-through doorway. The principle of framing the rocker is here shown, and to obtain certain measurements with-



out using timber of under thickness the existing vacancy or space between the inside framing, to which it is connected, is fitted up with wedge pieces, glued and screwed on.

CHAPTER XXXI

CONVERTIBLE TWO-SEATER

It frequently happens that it is required to fit a sliding seat to the platform bottom of the bucket seats, which involves little or no difficulty with the present type of chassis with their long frames, owing to the introduction of the live transmission axle doing away with the chain drive; but whatever the drive it is essential that we have some 4 ft., measuring from the centre of the high wheel to the front edge of the front seat. In the bucket seat drawing the back part of the frame of the bottom is lengthened; if that is undesirable, then a bar can be framed across the sliding bottom at the hind part of well, to meet the fixed bar of bucket seat bottom. In those bodies that slide it is important to make provision for a strong combined body and door plate, extending the full length of front pillar, round the doorway, with T-flaps across the bottom bar, also a corner plate on the seat, extending up the pillars along the elbow rail, likewise a corner plate on the inside at the hind part of well bottom.

The body stayed in this manner should not move, while a light cross rail on top can be fitted shaped to fit the bucket seats which will further firmly secure the front part of sliding body.

Fig. 2 on the side-entrance drawing (Plate XXXVIII) shows part of the rocker and its framing, with the front and hind standing pillars when got out ready for fixing. Fig. 3 shows the front standing pillar rebated and cut to secure the rocker. Fig. 4 shows the hind standing pillar, and its shape for framing to rocker and rail; while in Fig. 5 is the method that may be employed in lapping the rail to pillar, the half-round moulding used and the hinging of door. These sketches constitute the principal details of the usual mode of framing well and bottom, the bottom side being arranged to slide on, as in Fig. 6 or Fig. 7. All the securing of framing is from the inside, and the substance of pillar is $1\frac{1}{2}$ in., but varies according to the turnunder. Great care is required in fitting up the front pillars to fit existing bodies, so that when finally fixed they slide sweetly into place. Fig. 6 shows the section of chassis frame with the bottom and top runners and boot-sides, and a brass or iron plate standing down, which latter acts as a guide when sliding the body on and also keeps the body in position. The recess at hind part has a piece of framing screwed on underneath the hind bar to fill

PLATE XXXVIII.

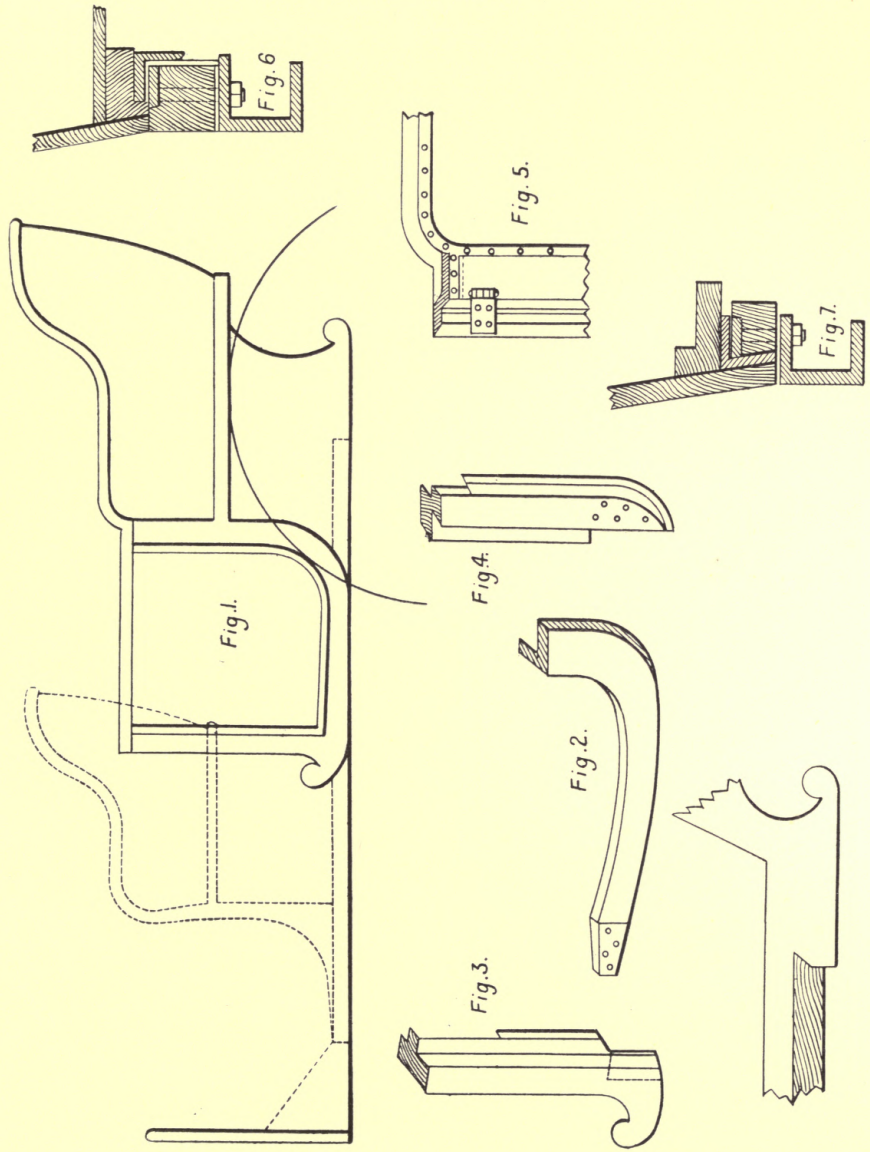
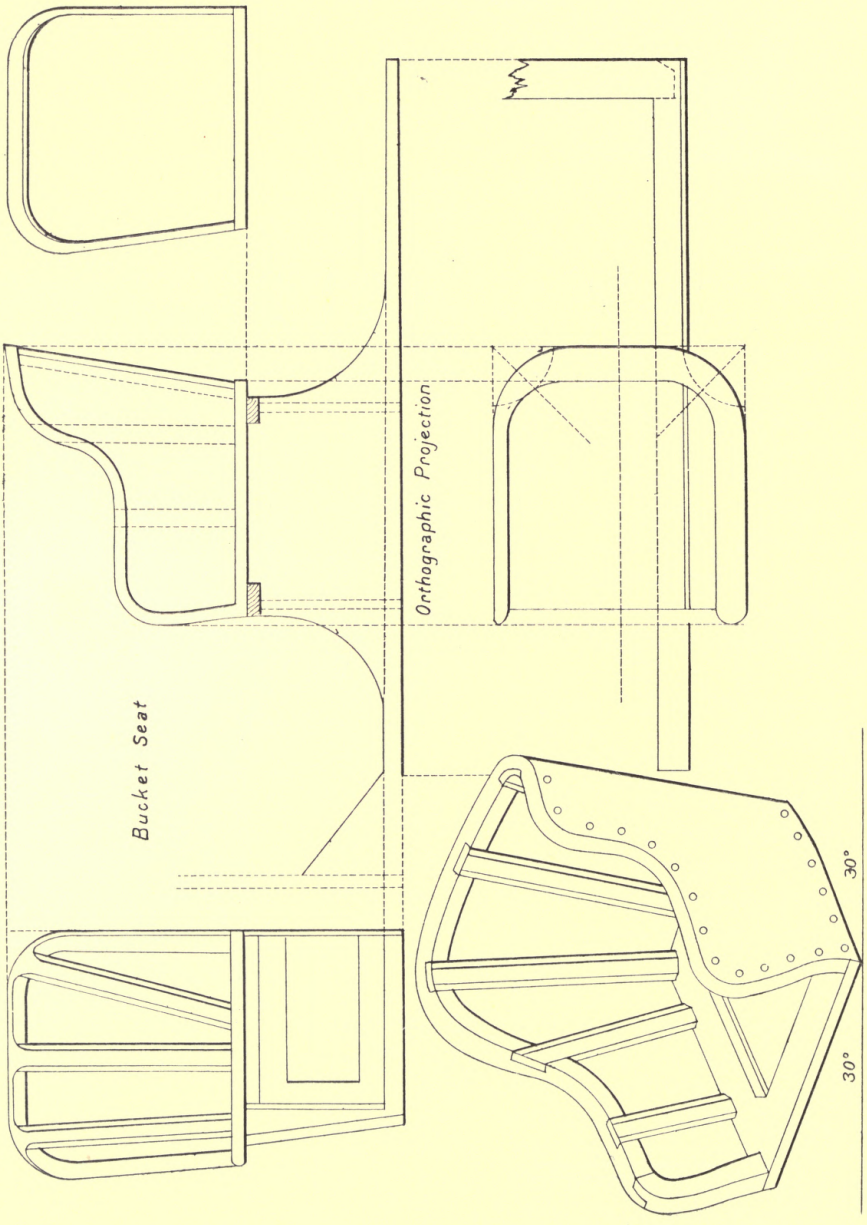


PLATE XXXIX.



up the space between chassis and frame. Fig. 7 shows another way of doing the same work, the runners being between the body and chassis frame, with the angle plate securing the long bottom-sides to the boot-sides. The body is secured when in position by four $\frac{3}{8}$ in. bolts arranged where they are easy to get at. It is necessary that the bodymaker, apart from care in fitting up the several parts to existing frame and body, should make due allowance for clearance, so that it slides easily when painted without rattle or movement. If there is any objection to bolts for securing the sliding body, there are several fasteners and a few patent sliding apparatus on the market; the mechanism of these is easily fixed. The working drawing of bucket seat is self-explanatory, but its size, shape and to some extent purposes for which it is employed determine the material used and how it should be built.

On the one hand, great strength is necessary, appearance and shape being a secondary consideration; while, on the other hand, especially when used and fitted for interior use (as armchairs), extreme lightness and comfort is necessary, and it should be well designed with secure fixing at the base for movable mechanism or appliances. Millboards, three-ply and aluminium, are used for shape of panelling, while a framed well seat is best for comfort. Three-ply and all the panelling materials with a stout bottom framing, stiffened by battens, is necessary for the ordinary two-seater with bent top rails, in preference to the sawn out and spliced corner rails, and considering the labour used to frame the rails, bent are the cheapest. They may be framed of three pieces, but when made out of five pieces there is less cross grain. In getting out the shape to full size this can be easily done by marking the bevels and pitch on paper full size. Most of the seats of this description are made plain on outside surfaces, and the mouldings fixed after the panel is on.

Plate XXXIX illustrates the framing up, jointing of battens, and rake of a bucket seat.

PLATE XL.

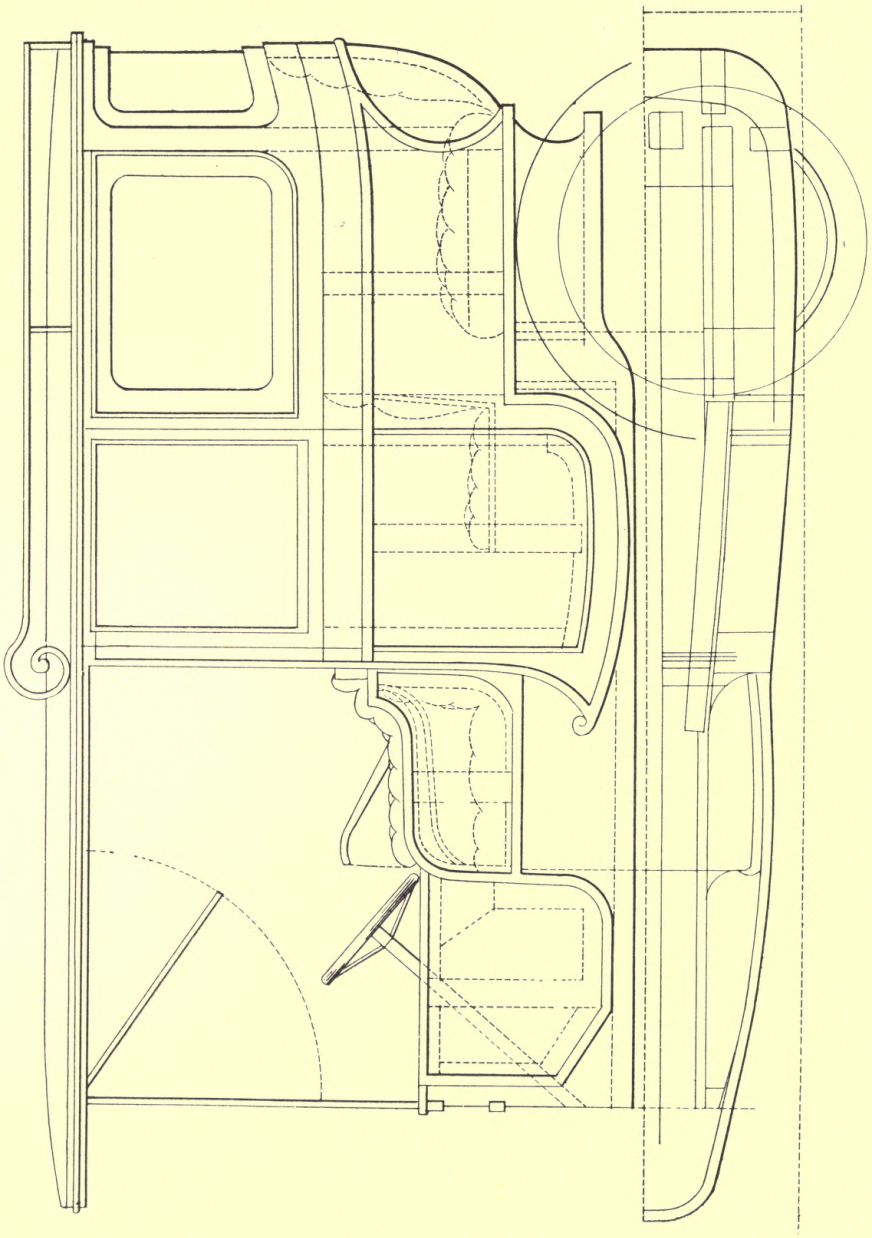
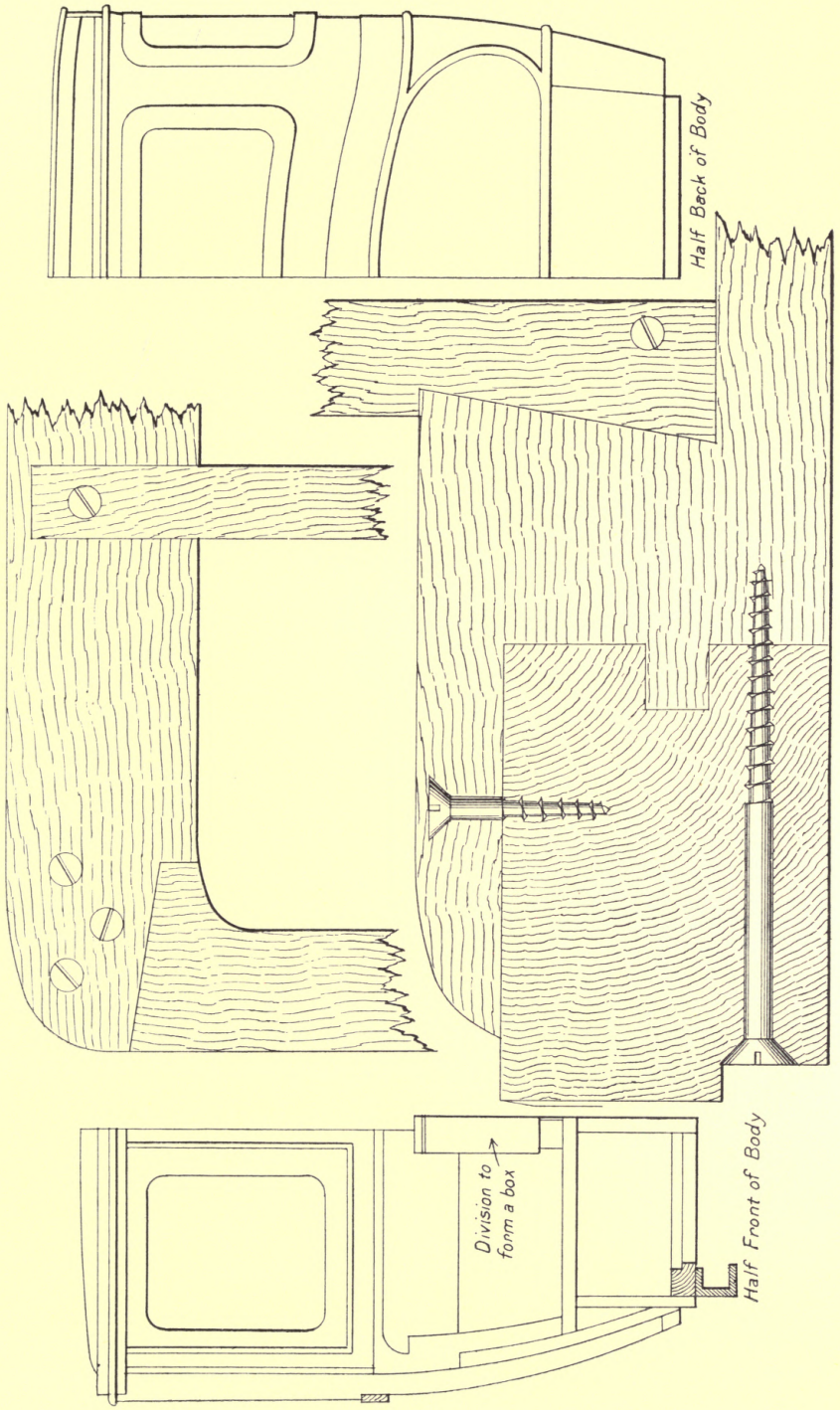


PLATE XLI.

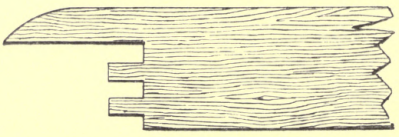


CHAPTER XXXII

ROUND-CORNER SINGLE LIMOUSINE (SIDE ELEVATION)

(*See* PLATES XL AND XLI)

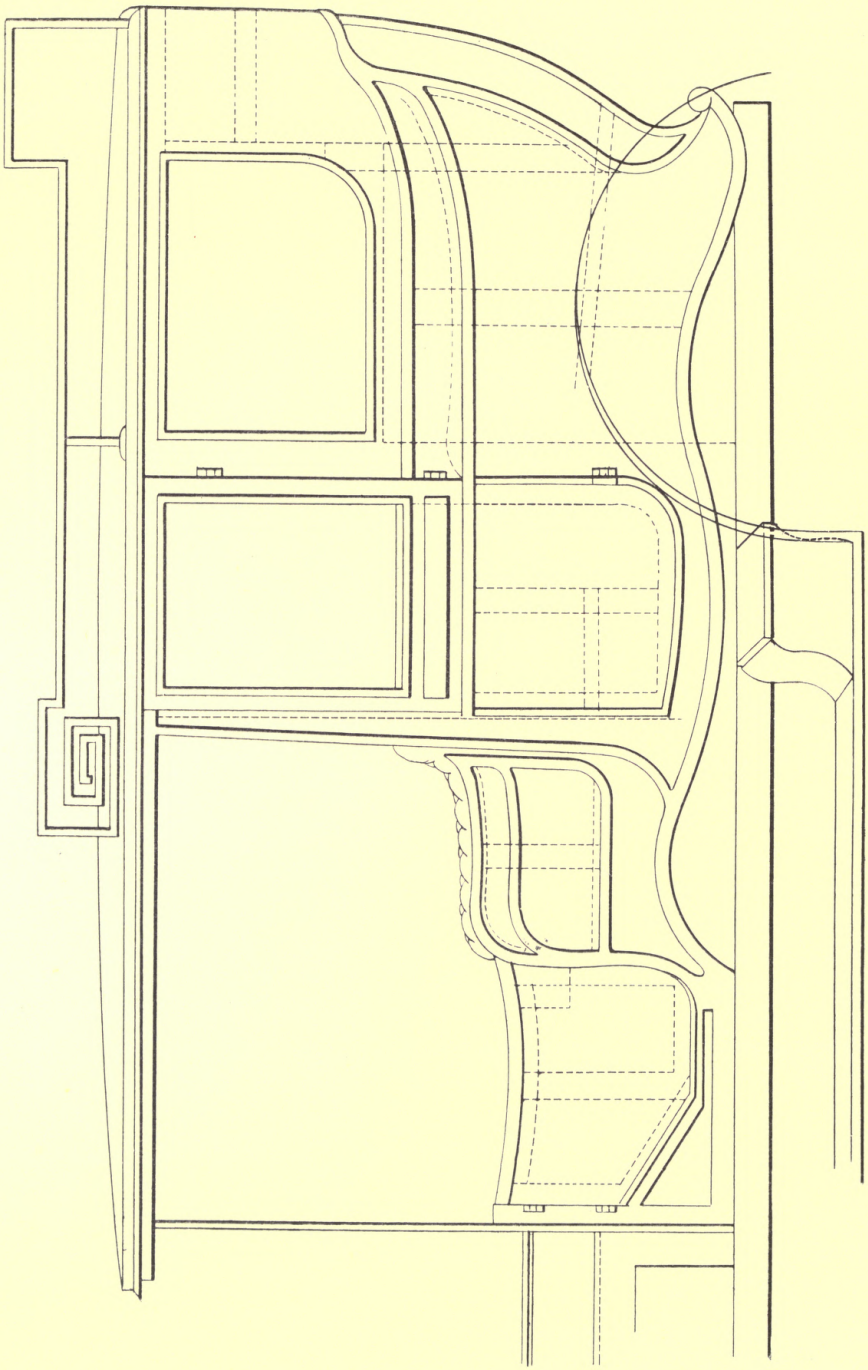
IN making the full-size drawing the bodymaker will require the usual chassis dimensions. All the vertical and horizontals will then be put in, together with the outline of the rear wheel, the position of the steering, working from the plumb line of dash. The arrangement of seats can be seen, and any type of occasional seat fitted so long as the leg-room is comfortably arranged. There are drop lights to the body in front and door, and the hinge pillar of the door is kept $1\frac{3}{4}$ in. thick and the shut $2\frac{1}{4}$ in. In this body we have a seat moulding and recessed rocker, forming a well bottom. There are metal panels and mouldings all round, gauge 20 being used for bottom and 22 for top if steel. The ground plan of body or cant in the bottom section of drawing will have to be carefully made up from the pillar pattern. The front seat is divided in the ordinary manner. On the plan of body the hinge centre will be seen from which the bevel of the shut of door can be got by striking an arc. The half back and half front views show the appearance of the body and method of framing up these parts and will assist in the making up of the pillar pattern. The full-size section shows a method of lapping the front canopy extension rail on top with the hoopstick notched in, which is preferable to cutting right through at the cant rail in front. Many bodymakers splice a swept corner piece to the rail to form the corner. The seat bottom side is shown with a stump tenon and lap on to pillar and screwed, but this is only one of the many ways of framing this part ; it is also sometimes framed with a double tenon.



The metal panel is pinned on, and the aluminium mouldings screwed on all round the front. The seat rail of the rear seat is lapped on, dovetailing, the seat being welled, not panelled.

In marking, the shoulders of the joints of the pillars having the sweep in two directions, lengthway of the body back and downwards, there must be no bending down of patterns, but all shoulders marked from the square line. The unerring principle of the square line must be closely followed for accurate work.

PLATE XLII.



CHAPTER XXXIII

LIMOUSINE WITH FISH-TAIL CORNER AT REAR

(*See* PLATES XXXIII, XXXIV, XXXV AND XLVI)

THE body here designed is for a chassis with the distance from dasher to front of hind wheel 6 ft. Besides the shape of pillar we have a serpentine moulding on the bottom and a double step, with enclosures, to get at the sprocket Thus it is designed for a car with chain drive. The transmission now being the direct drive, few cars are made of this pattern, but often a body has to be fitted to an old type of chassis. In most factories the body would be made with metal panels entirely, the mouldings being planked on to give the most important lines of body. In making the cant board it is as well to plot out or set off at least four parts in the pillar, to get the proportionate curve at the corner pillars, and that the two corner pillars be swept in at these parts, so that the panel beater is assisted and has no trouble with the corner panel.

If the pillar is worked out of the solid, with wood panels for a first-class job, it will take 9 in. stuff ; but when finished it is considerably lightened out on the inside. The scroll end is worked up like the bottom side, but in many cases this may be dispensed with. The top metal panels should be of gauge 20. If the lines in the full-size drawing are carefully followed and metal panels used, a very cheap and important-looking as well as roomy body will be the result. The front seat is framed up independently of body, to give 3 ft. 6 in. on the inside ; but this will be dependent on the type of chassis for which the body is intended. It will be noticed that the line of hinge gives a wide entrance, and also that the luggage rail harmonizes with other parts of the body. Figs. C, D, E (Plate XXXIII) show the framing of front standing pillar, which has a toe or finish with a scroll dub-end (Fig. C). The joint runs in a line with bottom moulding, being mitre joint, with the scroll on the rocker-bottom side (Fig. D). The joint carried straight across horizontally the pillar is in each case lapped on and screwed (Fig. E). The pillar is carried right through with a vertical joint. Plate XXXIV, Fig. F, shows the method of framing the back rail into the corner pillar with an outside mitre joint. Fig. G is the framing of the foot of the standing pillar, and shows how the pillar foot is squared with inside edge of runner, the lap being made $1\frac{3}{4}$ in. by $\frac{7}{8}$ in., the pillars of limousines being square with the rocker at bottom. Fig. H shows the method of framing the cant rail to the corner pillar with a lap and screw, two screws being sometimes used.

PLATE XLIII.

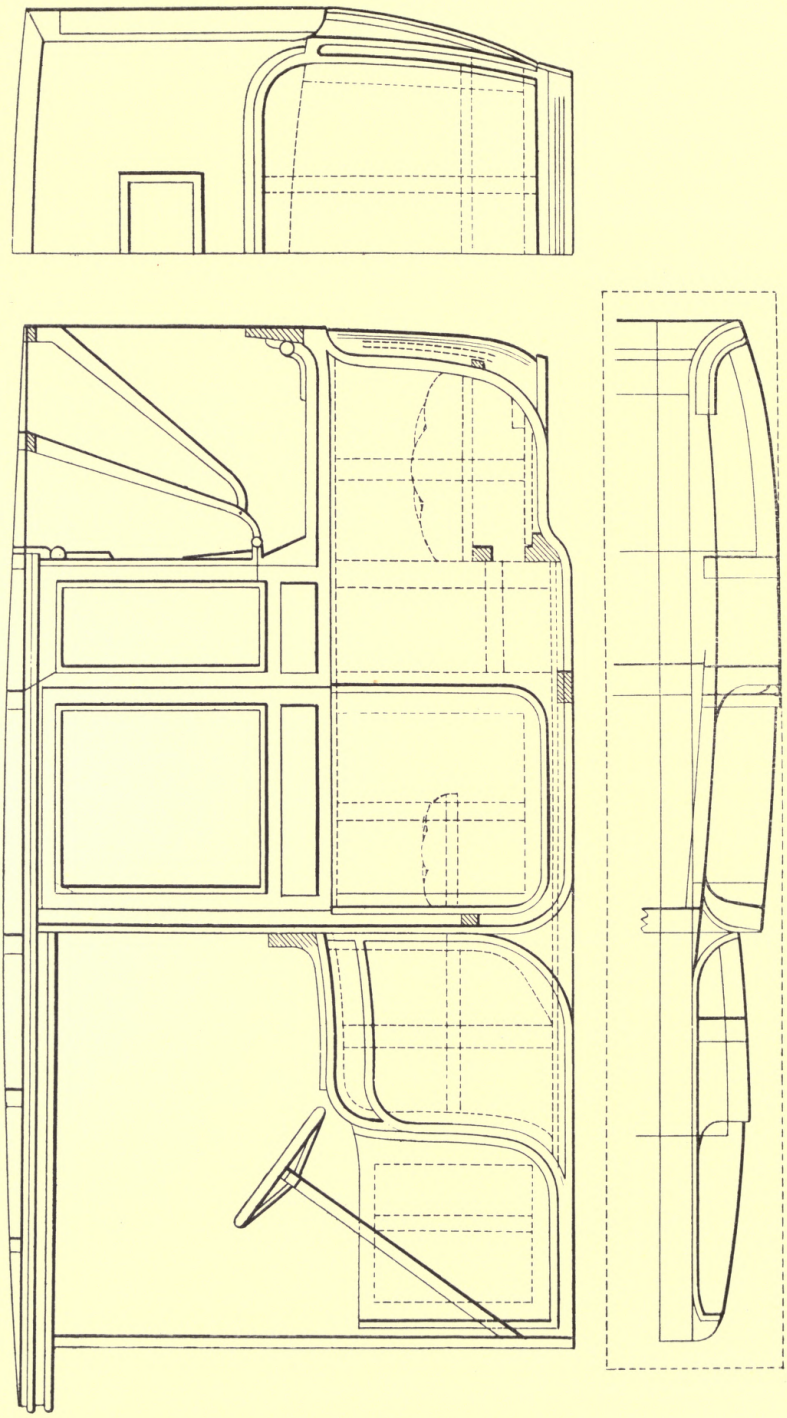
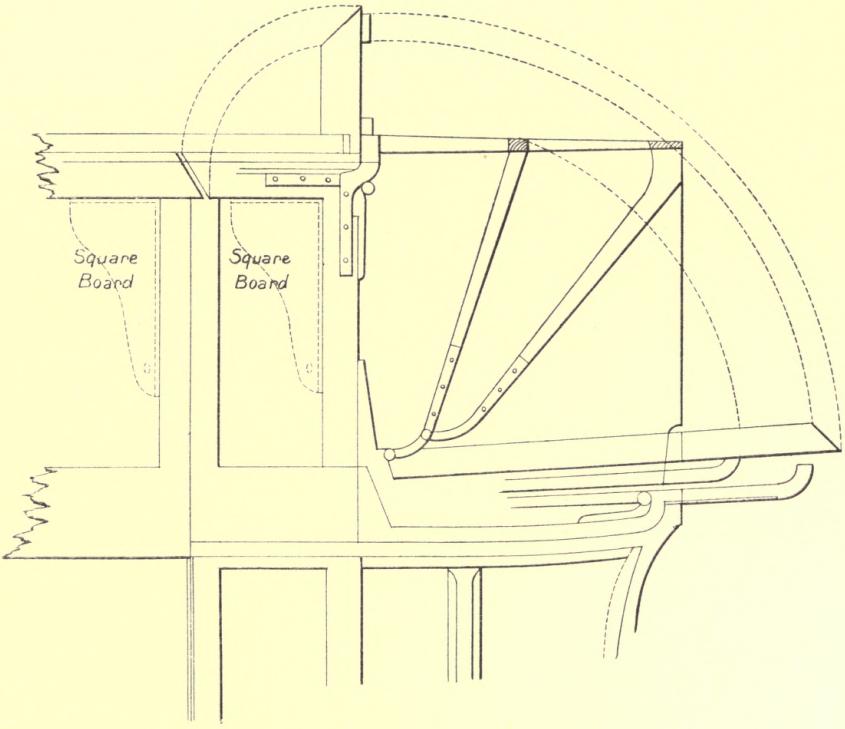
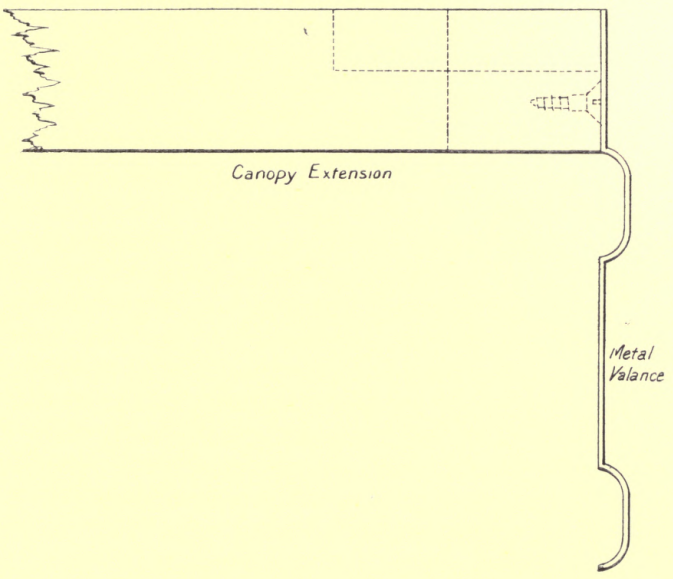


PLATE XLIV.





CHAPTER XXXIV

QUARTER LIGHT LANDAULETTE

(*See* PLATES XLIII AND XLIV)

THIS design differs from ordinary types of this description of bodywork in the shape of the front standing pillars, dispensing with the ordinary shape toe, but having a perfectly straight pillar, lapped on the rocker with a rounded moulding worked up. If the design be carefully worked out a nice shaped roomy body will be the result, a relief and more to the taste with many carriage users who are not very fond of the clean flush-sided body. The doors are fully framed for ordinary glass frames, and the body carries six persons. The various measurements and other arrangements of parts together with framing details can be seen from the drawings. While diversity of opinion may exist as to the materials for framing and panelling, it is a matter of fact that in a body of this description, with the framework judiciously "lightened out," the orthodox method of ash for framing and mahogany panels is quite as light as the body with metal panels and far more durable.

Many builders will frame in the corner pillar out of ash as shown on Plate XXXIV on account of the solidity, firmness and strength and supports to be obtained, and some prefer the method shown on Plate XXXV; but if the question of cost is considered, the metal panel answers the purpose. Plate XXXVI shows no less than three different forms of construction for framing the cab-shape front, all more or less employed to give the same results. The solid mahogany quarter-panel, when desired to have concealed joints, is covered with silk glued on neatly and cleaned off. But the full section sketch showing the door shut pillar and standing pillar framed with grooved mahogany panel is the practice to be desired and is followed by the best body-builders in the trade. This type of body is frequently panelled throughout with 22 gauge steel or 18 gauge aluminium, with moulding of aluminium planted on. In the same manner the deep valance of canopy extension overhanging front stanchion iron 6½ in. is made of metal in one piece, the beads being moulded on with the bottom edge turned and wired (Plate XLIV). It will be seen from the interior framing that though the chassis is cambered up at the hind part we get—what at all times is desired—a straight inside flooring of bottom. Length of chassis on frame for body-building is 8 ft. 9½ in.; head-room, 3 ft. 10 in.

While writing about this type of body I will describe the construction of the head, but a fuller description of hoods will be found in the chapter on " Cape Cart Hoods, etc." The fittings for the landaulette head are of the usual types of the elbow pillar with hinges of a pattern that will allow the head to fall nearly flat, and with the necessary clearance behind the back panel.

The interior sketch of the off side on Plate XLIV shows the method of folding of cant rail, pillar top and slats, with their hinging and jointing. Care must be taken that the cant rail and flap must be fitted and hinged to open out perfectly in line when the head is down, while they should stand square when it is up and locked (see dotted square board, Plate XLIV). When in this position the glass frame must slide up and down with the same freedom as it does in the door, therefore the greatest accuracy and care is required to get exactitude in fixing the fitting. The folding flap cut with the bevel joint should always be cut $\frac{1}{4}$ in. to $\frac{1}{2}$ in. longer than the width of quarter light, to take a bearing on pillar top, and not level with the inside of pillar. In letting in the cant rail hinges at the top, they must be let in equi-distant from the edge of pillar and the cant rail, so that the front joint, when the flap is up, is in a line with the pillar top.

The pillar must work square to the joint both in a vertical and horizontal direction, so that when the head is locked a clean and neat jointing is seen. Some bodymakers in cutting these joints allow $\frac{1}{8}$ in. for fitting; nothing of that is required if they are correctly marked. The joints may be cut with a sharp tenon saw and only the shoulder should require cleaning up.

The hind elbow props, shut in the solid with the corner plate, must always be strong enough to resist the strain of the hood, but accurate fitting is as necessary as with fixing, for the corner of the body at this part is materially strengthened by this plate if well fixed with No. 14 screws.

Plates XLV and XLVI show front and back views and side elevation of a single landaulette.

PLATE XLV.

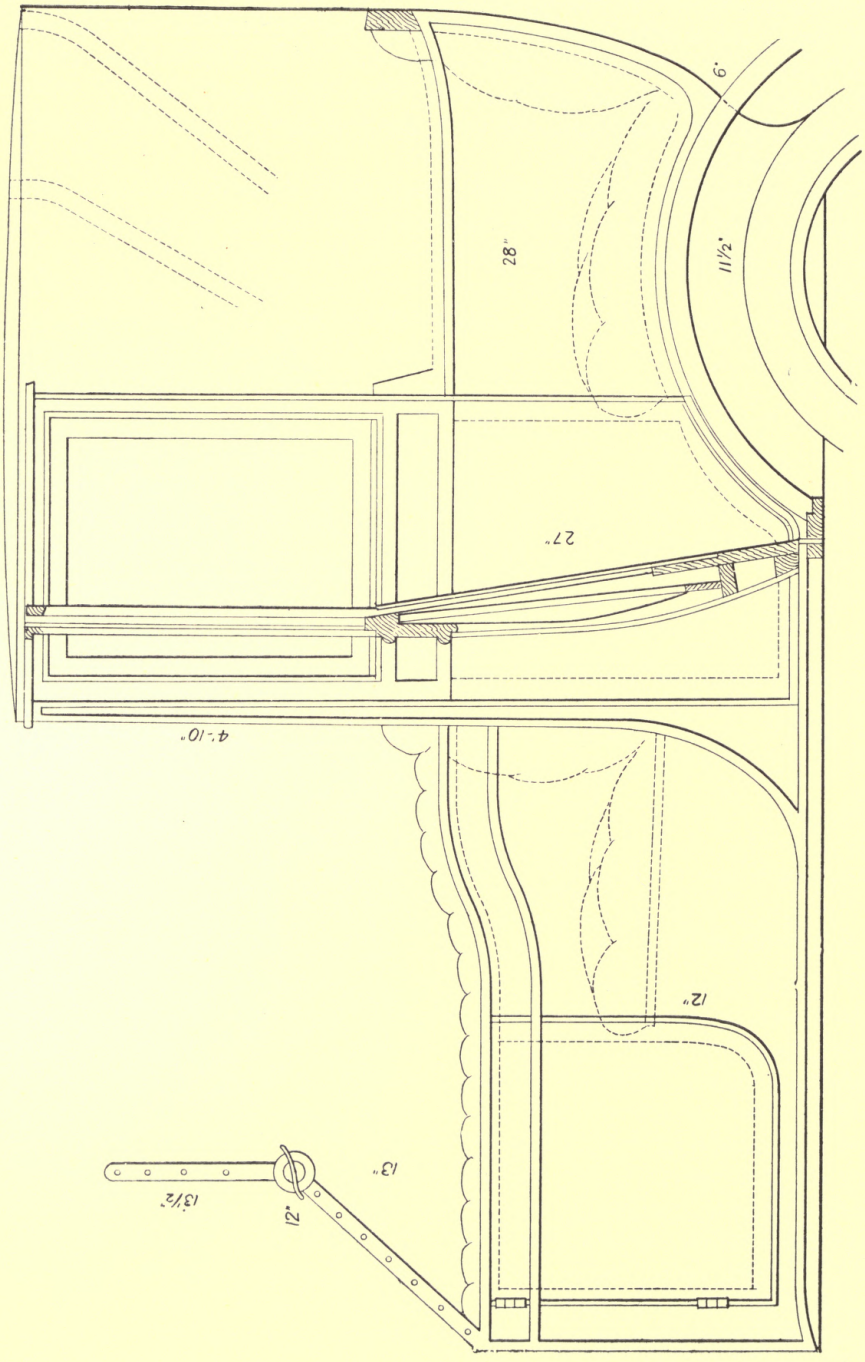
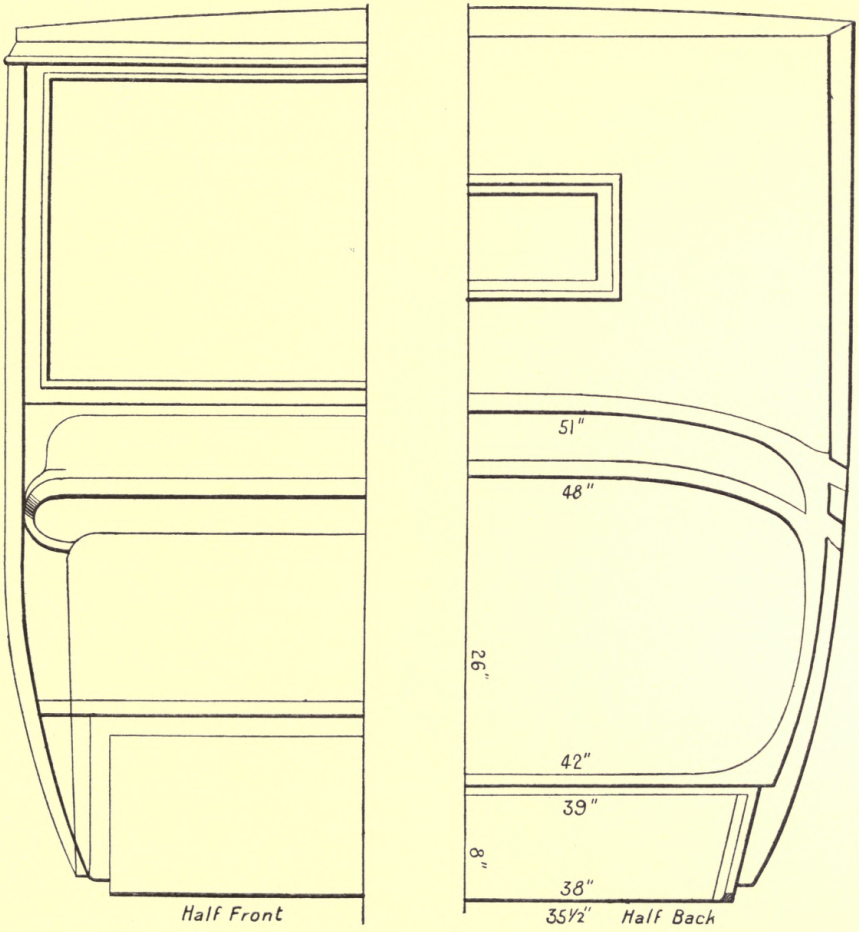


PLATE XLVI.



CHAPTER XXXV

PAINTING

Process of Painting.—The object of painting a motor car is for preservation and embellishment and to render the various tinted woods and metal used in the construction one harmonious whole that will be attractive and pleasing, and to give protection and durability to the materials employed. In the best London houses a log or tariff is arranged, stipulating the various number of coats and their order, and this process is adopted throughout the country for all good work that is to be of high finish. The body is carefully dusted off, all corners, raw edges, white lead and other foreign substances are cleaned off and sand papered, and it is then given—

(1) Primary coat of lead colour, allowing twenty-four hours to dry.

(2) Thin coat of lead colour, allowing twenty-four hours to dry, working at these coats so that all pin, screw and other holes are filled up. The basis of these coats of paint is white lead. Following these coats the body may be half stoppered up with dry white lead mixed with japan, and when hard given at least five coats of filling up, allowing twelve hours between each coat, and for a good job six or seven coats. There is great diversity of opinion amongst painters as regards the primary preparation of a body; for instance, some put the filling on, well working it into all the holes, so that after all the coats are put on there will be little of the holes left to stop up, but before putting on the last coat what is seen of the holes may be filled up with hard-stopper and left to stand for a few hours, allowing it to shrink in the drying, and then putting on the last coat; the idea of this is that the less stopper you use the less there is to fall out.

When hard give a coat of staining colour. The job should stand for twenty-four hours before rubbing down with pumice stone. After rubbing down, the work should be allowed to dry thoroughly to get the moisture out, then given two successive coats of thin lead colour, again stopping up any inequalities, carefully facing down, and when all is quite clear and solid, finishing with one thin coat of final lead colour, or light colour approaching the tint of common colour, though this is often neglected by many shops. It should be understood that all the coats should be kept light or dark as the final finish of the job demands. The body is now ready for its colour, we having prepared a surface of some twelve or

fourteen coats. Briefly the chassis may have two coats of lead colour, stop up, two coats of common colour, one coat of thin varnish colour, five coats in all, flat where the lines are, finally varnishing or finishing as described elsewhere. Should the body be finished in blue, which is made with prussian blue to the required shade with white (keeping the white clean), two coats are given to make the job solid, mixing a portion of the common colour with ultramarine (half and half it is called), so as to dry with an egg-shell gloss.

All colours are preferably mixed with varnish and a little gold-size. Some painters use the varnish or gold-size alone for binding purposes, as sometimes one upsets the other, and it does not dry hard. Quick-drying colours can be made with hard-drying varnish alone with turps, providing care be taken. The next coat is clear ultramarine mixed with varnish and turps, then a coat of glaze. This is hard-drying varnish with a fair amount of ultramarine, these successive coats of varnish colour being lightly flatted down with ground pumice stone and felt. If a limousine, the black parts are given a coat of solid black and two coats of japan, the whole being flattened down with pumice stone and felt and made smooth and clean, the mouldings and body picked out or fine lined, and the whole being given a coat of hard drying finishing varnish. A really first-class job again is faced down, some using stone, some cuttle-fish bone to flatten, and given a final coat of varnish, when the car is ready for the trimmers or the road. It is needless to remark that a careful painter, using good materials, permanently develops all the good points and lines in a body, while a careless man mars the beauty of otherwise faultless work. A painter can ofttimes rectify any small error on a moulding or line by judicious fine lining, though if the panels are not free from blemishes (as often seen in panels and mouldings) the best work and materials in existence will not eradicate or in any way put it right. In fact, the whole of the body should be well cleaned off. The solid black for a limousine, as already mentioned, should not be "quick black," for it is likely to crack. The best way is to mix either vegetable or drop black with japan to dry with a gloss, and set nice and hard, flat down lightly with pumice dust and water, and wash off clean and give two more coats of japan, as required, and flat between each coat. An extra coat of japan is better than an extra coat of varnish, as varnish is inclined to turn the black green, but of course you must finish with varnish.

Manufacture and Composition of Colours.—*Lead Colour.*—White lead, linseed oil, turps and vegetable black to shade required, adding gold-size as a drier. Proportion : 2 oil, 2 turps, 1 gold-size.

Filling-Up.—Grafton paint or filling-up powder. Say 3 lb. filling-up powder, 1½ lb. of white lead (tub or oil), mixed to a fairly even paste, then add ½ pint of gold-size, and ½ pint varnish bottoms.

Staining Colour.—A small portion of filling-up powder, darkened with black, thinned with turps.

White Lead is made by what is generally known as the " Dutch " process. This consists in attacking metallic lead in the form of " crates," " grids," or " spirals," and subjecting simultaneously to oxygen and water vapour. The metal is gradually converted into a mixture or compound of lead carbonate and lead hydrate. This is collected and ground in raw linseed oil, packed in casks ready for use.

Lamp Black is the soot from resinous woods and burnt oils.

Drop Black, or ivory black, is ivory charred to blackness, bone black made in the same manner, ground and sent out for use.

Red Lead is an oxide of lead.

Indian Red is a rich iron ore from Bengal.

Scarlet and Crimson Lakes are from cochineals.

Cochineal consists of the dried wingless females of a species of coccus (*C. cacti*). The best quality comes from Tenerife, and contains about half its own weight of colouring matter. This matter is a glucoside, to which the name of carminic acid has been given. When this substance is treated with weak sulphuric acid it is resolved into a sugar and another colouring matter called carmine red. They are semi-transparent and do not dry hard when ground well in oil.

Umber (a brown pigment).—This earth is found in Cyprus, from whence the best variety has come for some time past. An inferior quality is found in Devonshire.

Gold Size and Varnish are chiefly made from gum, copal boiled in oil, matured in vats, strained and canned ready for use. The driers used are litharge red lead and umbers, also a proportion of turps, which is added on a graduated scale according to its required properties of drying. It is as well to remember that red lead and umber are driers in themselves, that blues, drop black and lakes are bad driers, even in varnish, and will not dry in oil.

White Work.—In preparing the white a small portion of ultramarine blue should be well mixed and ground very fine into the white, and for the last coat of white a little pale varnish should be added which will prevent it looking cloudy, and it will be more solid if properly and quickly painted. In painting a large panel the addition of a few drops of linseed oil to retard the drying is very often an advantage, especially in very hot weather, using a brush, not too long, which gives the painter more power to control his colour, and prevent it being ropy. This idea stands good in painting any colour. In motor work four coats are requisite if it is to be a white, blue, or lake. In other colours, after the second coat of lead colour, three coats are mostly required if put on thinly and well worked. Cheaper work can be done with one coat of quick colour and a second coat with a little varnish added to it.

Blue.—In painting a blue use two coats of prussian blue, lightened up to the desired shade, finishing with light ultramarine blue, without any white being added to it ; thin the fourth and last coat with varnish and add a

very small drop of linseed oil to a portion of the quick ultramarine blue for the finishing coat. All body work should be varnished with one coat of hard-drying flatting varnish and can be flatted down the following day, and finished off with finishing body varnish. It is always advisable, if possible, to give each coat of paint and hard-drying varnish one clear day between each coat before the finishing and last coat is put on, but circumstances govern this. It is necessary to paper off carefully and slightly all panels between each coat of paint with No. 0 paper and flatten with wet pumice dust and cloth, being always particular to wash out all corners with a small water tool, as the least portion of dust will spoil the whole job.

Crimson or Purple Lake.—This colour should be painted with purple brown, or indian red, darkened with drop black, after the first coat ; a little rose pink may be added to the second coat, and lake for the third coat, the finishing and fourth coat to have a little varnish added to the previous colour Lake having very little body, the shade of colour must be got in by bodying up the second coat, similar to blue.

All lakes and reds should be got on as even as possible and varnished before flatting, as the flatting process robs and takes the colour out ; this also applies to blue, and should always be done if the time, etc., permits.

Colours.—In mixing a plum colour, vermilion red mixed with blue will give the shade required. A very good light green can be made by mixing light lemon chrome yellow and prussian blue together. To make a salmon colour : white, adding a good red and a small portion of light purple, brown, or orange chrome yellow, will give the desired tint. A good plan is to put two or three shades of colours upon a piece of glass noting the preparation of each. It is more satisfactory to customers if samples of colours painted thus can be shown to be chosen from.

In mixing up paints in either the dry or liquid form the following list will be helpful in obtaining the correct shade. A larger quantity of the first named colour must always be used.

Dark green and purple make bottle green.
White and medium yellow make buff tint.
Red, blue, and black make dark brown.
Bronze blue, lemon yellow, and black make dark green.
White, medium yellow and black Japan make drab tint.
Lemon yellow and bronze blue make grass green.
White and black make grey tint.
White and purple make lavender tint.
Red, black and medium yellow make maroon.
Lake and purple make magenta.
Medium yellow and purple make olive green.
Medium yellow and red make orange.
White, ultramarine blue and black make pearl tint.
White and lake make pink.

Ultramarine blue and lake make purple.
Orange, lake and purple make russet.
Medium yellow, red and white make sienna.
White and ultramarine blue make sky-blue.
Ultramarine blue, black and white make slate.
Vermilion and black make turkey red.
White, yellow, red and black make umber.

Vermilion Red.—Bodies painted this colour are often painted over a light flesh colour, but it is more durable if painted upon a pure white with two coats of vermilion, and one coat of varnish colour. Some painters instead of making up the ground in white or flesh colour, get it up in red ; this is a wrong practice, owing to the red going black after the turps, oil, etc., has dried in it, which blackness works through to the surface.

In painting a "good black," paint with quick-drying drop black one coat, then one coat of clear black japan ; in picking out black, if the work is in a hurry, ultramarine blue bound with japan is very useful as it will not "crack."

It should then be slightly flatted, only sufficient to take off any small nibs of dust, being careful not to rub off the edges, then one coat of japan and varnish mixed of equal quantity, then another slight flat and two coats of varnish. Always use hard drying for the first coat and finishing body varnish for the outside varnish.

Mixing Quick Colours.—Colours ground in turps should be bound with about one-third of gold-size. If the colour be mixed with gold-size, mix into a thinnish paste and thin down with turps ready for use.

Colours Made in Varnish.—If colour is not needed to be painted over the same day, a durable colour is one made up stiff in varnish, and thinned down in turps with a few drops of linseed oil. Too much oil should not be added, as if a sufficient time is not allowed for it to dry, it has a tendency to blister, while too much turps should be avoided in oil colour ; in quick colour it is likely to perish and not wear very long.

Notes on Quick Colour.—Care is needed not to put too much gold-size in its preparation, as it would have a tendency to crack. Quick colour should never be put upon oil or varnish colours before it is thoroughly dry, for this is also liable to crack ; whether it be surface work or a picking out line, it most assuredly pays to wait until the previous coat is dry, otherwise it would have to be redone.

Mixing Oil Colours.—Make up dry colour very stiff in oil, and bind with about one-quarter the quantity of gold-size, thinning down with turps, ready for use. This binding does not alter the colour. This binding is all right if the colour is to be used immediately, but if stood by for a few days it will become what is known in the trade as "fatty" ; it will dry with a tack, and the varnish being put on will dry the same. For primary coats such as white lead and flesh colour : colour made up in oil

can be bound with about one-third ground patent driers and thinned down with turps. It is preferable to bind with "patent driers" for light or strong colours, but for transparent colours "Terebine Driers" is advisable, so as not to alter the colour. Colours mixed up with linseed oil require a little more driers than colours mixed up with boiled oil. Varnish generally improves by being exposed when dry to the air in the "shade" and washed occasionally, and dried with an old dry chamois leather. "*Terebine Driers.*"—This is a substitute for driers for paint made up in oil, a good 1½ oz. being used to every 1 lb. of paint, though in very hot weather 1 oz. is quite sufficient.

Hints on Painting and Varnishing.—It is essential to follow out the following instructions to ensure success in painting. Clean off all old paint, rust and dirt, and well paper and dust off before painting the first coat, so that the putty may adhere. Keep brushes in water only up to the binding and rub out before using. Use the wrist freely, so that the brush may be worn level, which will enable a painter to lay off his work more satisfactorily. After stopping up with japan stopper, paper off again, so as to get a level surface. Paint well and quickly worked will make a more solid surface. Finish off lightly.

Varnishing.—A dull surface will always varnish up better than a glossy one, therefore if the surface is very glossy, flat down with pumice dust and water before giving it the finishing coat of varnish. It will prevent the varnish from sissing, which very often occurs. When unable, through price or time, to flat the work, it should be well rubbed with a damp chamois leather just before varnishing. If the job is a quick one, 1 teaspoonful of Terebine Driers to 1 pint of varnish can be added. This will make the varnish fit for flatting the next morning for the finishing coat.

Order of Painting a New Body.—

Three coats of lead colour.
Hard stopper up all holes and uneven places.
Fill up with five or six coats of filling up.
Coat over with staining colour.
Rub the whole body thoroughly down.
One thin coat of lead colour.
Stop up and rectify any bad places and face down.
Coat with finishing coat of lead colour.
Face (and smooth) down.
Coat with three coats of colour.
Coat with one coat of varnish colour.
Black parts, two coats of black.
Japan two coats, flat after each coat. Pick out and fine line, or otherwise decorate after flatting.
Flat and give varnish, two or three coats all over.

Repainting Old Bodies.—If all paint is burnt off, the body to be

brought up exactly as above as to process and number of coats. As a rule it is a dangerous thing to burn off the old paint on bodies that are being repainted, as metal panels are likely to buckle, but of course woodwork is different, and it is not likely to be affected. Generally it is not much trouble to strip the metal with a stripping knife ; if this should be difficult, clean off all loose paint, and paint bare places with lead colour. Stop up holes and rough places. If the job will pay, give two or three coats of filling, and rub down, otherwise repainting as follows :—

Body.—Rub down with pumice stone.
One coat of lead colour.
Hard stopper, rub and face down.
Second coat of lead colour, when dry rub down.
Three coats of *colour.*
Black parts, two coats of black.
Two coats of japan.
Flat, pick out and fine line.
Finish with two or three coats of varnish.
Chassis.—One coat of lead colour.
Putty or stopper and sandpaper.
Three coats of *colour.*
One coat of varnish colour.
One coat of varnish.
Pick out and fine line.
One coat of finishing varnish.

Should any number of coats be left out on the score of price of estimate, then one coat of lead colour, one coat of common colour, and one of varnish, but the above is for good work.

Heraldry.—Instruction for fixing transfer heraldry.

First wipe off the powder, then go over the design with gold-size (not too sparingly), using a small brush. When tacky, place on panel, press and rub firmly from the centre, " being careful to hold in position," until it is quite flat and free from any air-bubbles. Wet with sponge, at same time " dabbing with finger," which helps both to soak and to keep flat. " This is important." When quite soaked (in about five minutes), peel off from one of the top corners. Wash with sponge and leather.

Notes.—A few drops of varnish help to give gold-size a strong tack, if time permits. For " light " bodies use " varnish " ; thin it down slightly with turps. In sizing, do not go " only over the design " but " over and beyond," the paper absorbing all but that on the design itself. The greatest care must be used in handling the transfers, and it is better to test the tack always by sizing on a spare panel, as it is unsafe to touch the design when sized over.

Stained Wood.—Care is necessary in preparing the surface, planing and

papering off level the way of the grain of the wood. Light, medium and dark oak mahogany stains can be purchased ready for use. Put on with a brush or a sponge according to the desired shade, then give one coat of gold-size with a little turps, finely paper, omitting the edges, give a second coat of gold-size and turps, papering down again with sandpaper dipped in turps, well dust off, then one coat of flatting varnish, flat down with pumice dust and water, wash off clean, and give one coat of best varnish. If possible give two days between each coat of varnish before flatting; the more time is allowed the better opportunity will the varnish have of hardening, which lessens the risk of it going sleepy or dull. Varnishes have a great tendency to go queer, more so best finishing varnish, which is slower in drying. Various causes are assigned, but a change in temperature while drying is one of the chief causes, also the following too quickly before the previous coat has had time to properly dry. Smoke settling on varnish will not only retard the drying, but often cause it to dry dirty and cloudy. Varnishing too quickly often causes the varnish to dry pin-holey; also dirty water, not properly washed and leathered off, causes a smeared look upon the panels when dry, and another cause may be attributed to a wash-leather which has become slightly greasy and not thoroughly cleansed. It is to be noted also that the use of two different makers' varnishes is not always satisfactory; if the second coat has been put upon that of another maker, it may lose its gloss, although the previous coat be well flatted and perfectly dry. It has also been proved to be expensive to mix two different makers' varnishes together (although this is practised by some painters). A medium price varnish can be used; it is not advisable, and is rather risky for first-class work, but all right for cheap jobs.

Standard Procedure in Motor-Body Painting.—The principles set forth herein are taken by kind permission from an admirable pamphlet on the subject issued to body builders by Messrs. Wm. Harland & Son, of Merton, the well-known specialists in the production of durable varnishes and ready bound colours, and are those adopted by some of the largest manufacturers of chassis and motor coach-building in England, and are recommended as suitable for use in the paint-shop generally. Of course, it will be evident to the experienced painter that, in the ever-changing conditions of atmosphere, heating arrangements, etc., under which the painter has to work, modifications and variations of these principles may be occasionally resorted to with advantage.

As the panelling of motor-bodies is now almost entirely composed of sheet-steel, rust blisters are apt to show through the finished work unless measures are taken at the very beginning to prevent it.

A metal panel having been in a damp atmosphere will have absorbed a certain amount of moisture, and it is necessary that this should have evaporated before any painting process is begun; therefore the temperature of the paint-shop into which the car body has now come should be maintained

at about 65° F., so as to encourage the necessary evaporation. This temperature may be regarded as normal and should be kept up during the whole period of painting.

While this natural process of drying is going on, the panels should be rubbed down with coarse emery-cloth, so that a rough surface is produced on which the first coat will have a grip. It is important to do this both inside and out.

The whole body should now be carefully dusted, care being exercised to clean out all pinholes and sunk screw-heads. The panels should then be given a coat consisting of seven-eighths gold-size and one-eighth japan on both sides to prevent rust setting up. This might be left overnight, and when thoroughly hard, as it should be in the morning, a coat of lead colour should be applied to each side.

Eight to twelve hours should be allowed for this coat to dry hard, when a second similar coat should be given. Great care must be taken to dab these coats into every pin-hole and nail head. This second coat may be allowed twelve hours to dry.

Now proceed with the putty knife and hard-stopping to fill up and level all pin-holes, joints, screw-heads and every unevenness of surface. After going carefully over all the parts requiring stopping, allow four or five hours to harden. The complete levelling of the stopping will take place in the next process.

The filling-up coats should now be given, and Harland's Enamel Filling is strongly recommended for this purpose. A special thinner is supplied with it, and the filling should be thinned out with this alone to such a consistency that it can be easily applied with a brush. Apply six to eight coats, according to time and size of work, allowing each to get thoroughly hard before the next is given. Four to five hours should be sufficient.

Now give a " Guide " coat, which should be of a different colour, so that the painter can see in rubbing this off when there is no need for further labour ; but it should be remembered that this is perhaps the most important part of the process of coach-painting, and the greatest care should be taken that a perfectly level surface is produced at this particular stage.

It might here be said that the man who thoroughly understands rubbing, facing and flatting, is one of the most valuable in the paint-shop.

For the purpose of rubbing down, natural pumice stone is recommended as having the necessary cutting power to carry on the work effectively and quickly. It should be specially picked for the coach-painter, and it will be found very free from liability to clog. A slate slab will be found useful to rub it on, and water should be used freely to keep it clear. A sponge is required to clean down the work, which should be dried off with a chamois leather. The pumice should be cut into various sizes, so as to get close into mouldings, corners, etc. The surface, if this rubbing is efficiently done, should now have a marble-like smoothness. The filling-

up, being of a porous nature, will have absorbed a certain amount of water, and the work should therefore be allowed sufficient time for the moisture to evaporate. This precaution is necessary so that blisters may not form and show at a later period. The time allowed for this will vary according to the heat of the room.

The work being ready for painting proper, all filling overhanging the edges, and along the bottoms of mouldings, door lap-plates, etc., should be carefully cleaned off, so as to prevent chipping, and headings and locks should be cleared of any filling which would be liable to chip off through the slamming of doors. The panels should then be smoothed over with fine glass-paper and dusted off carefully, special pains being taken to clear out all corners and grooves. Now apply to the whole of the outside a thin coat of lead colour, and allow a night for it to dry and harden.

The final stopping up of all minute holes, scratches or blemishes should take place on this coat. If these are not detected now and removed, they will show up conspicuously in the finished work. Four hours should be given for this final stopping to dry and harden, when it will be ready to smooth or face with pumice stone in the same manner as in rubbing the filling, only that it does not require such an amount of labour. This latter process has now filled up the pores of the filling, and has given the work a fine glossy surface. The whole body should at this stage again be smoothed down with fine glass-paper and dusted off very carefully.

It is now ready for painting with the selected colour. Messrs. Wm. Harland & Son, of Merton, London, S.W., are specialists in the production of the finest range of colours extant, which are ground to an impalpable fineness, thus bringing out their purity, richness and brilliance; qualities essential to a high-class appearance in the finished motor car. The colour having been chosen, may be used as it is, if it has come ready ground from the colour manufacturers there is no need to pound it with mortar and pestle, nor to grind it on a slab with a muller, as in the old days. These colours may be had ground in turpentine, or ready bound, and can be made to dry in such time as the work requires. They should be mixed only in varnish and turps, adding just sufficient raw linseed oil to make them work freely.

This method serves to maintain their purity and brilliance for a much longer time than when boiled linseed oil and sugar of lead were important ingredients; doubtless responsible for much trouble in the way of pin-holing.

We now apply the first coat of colour, and it may here be said that these colours are, in the vast majority of cases, of such body or covering power that a coat of preparation colour may be dispensed with.

When the first coat is thoroughly dry a second coat is given, and this should be carefully rubbed down with No. 0 glass-paper. The final coat of glaze, which is made up of about two-thirds varnish to one-third of colour, should now be given. The parts of the body which are to be black should

now get a coat of shiny black, composed of a sufficient quantity of vegetable black added to the black japan to give it the required covering power. This, when dry, should be flatted down with pumice powder and felt, after which it should be washed down, using the water tool freely to remove all pumice from crevices and corners, and then dried off with a chamois leather.

Now apply the first coat of black japan. This, after standing twelve hours, should be flatted with felt and pumice powder as before; washed off, again using the water tool freely; and then dried off with the leather. After this the second coat of japan should be applied, when a dense jet-black surface should result. When giving the last coat of black, run in all the mouldings and beadings. The second coat of japan should be flatted in the same manner as the first.

Now give the whole body a coat of Undercoating Body Varnish, and after allowing twelve hours for it to harden—longer, if time is available—it should be faced down by an experienced painter with fine, hard, close-grained pumice stone. Some men prefer cuttle-fish for facing, and it is perhaps a speedier method, but it does not leave the same fullness as if finished with the stone. After this facing, which should be commenced at the top, working the pumice stone with an up and down motion, the flatting process should be gone through as was done on the japan. Now give the body a wash-off to make safe against any dirt or dust being left in the corners or tops of mouldings, etc. If an extra good job is required, another coat of undercoating may at this stage be given, the facing process being left out, flatting only being required. This coat adds to the fullness and brilliancy of the final coat.

Before the latter is applied it is usual to embellish the mouldings of the body with fine lines, either in contrast or harmony. In this particular part of the coach-painting art, the painter can make the body look shapely and elegant, and show the builder's work off to advantage, or, on the other hand, through lack of judgment in not following the bodymaker's design, produce an entirely opposite result. Perfection in lining is most important, for if the lines are ragged or irregular, they make the mouldings appear crooked.

After lining, the body is usually sent to the trimmer. This gives the painter's work a little extra time to harden, which is most beneficial to the final result. When the trimming is completed, the body is wholly flatted down as before, great care being exercised to remove any small nibs, or specks of dust, embedded in the undercoating varnish.

Before applying the finishing coat of Durable Body Varnish it will be found advantageous to go over each panel with a silk handkerchief, in order to remove any fluff that might possibly be left from the chamois.

In the varnishing processes Harland's Undercoating and Durable Body Varnishes will be found to produce the most excellent and lasting results. They should be put on absolutely fearlessly, and the painter should be

careful not to "play" with them too long, but having laid them off, leave them alone while the flow is still present, so that the varnish may finish the job itself.

The chassis may be treated somewhat differently to the body because, being an underpart with small surfaces, and generally coming into the painter's hand when the body is almost finished, it has to be painted in a much shorter time.

The dash and sides of frame look much better when finished if followed up in the formation in the same manner as the body, except that three or four coats of enamel filling will be sufficient. If there is not time for this process, give two or three coats of lead colour, stopping up with hard stopping, and glass-papering in between the coats. Artillery wheels should have an extra coat of lead colour, so as the better to fill up the grain of the wood.

Now apply two coats of colour, and one of varnish colour. Should time not permit of that, then one coat of colour and one of varnish colour may suffice.

The picking out or broad lines should now be put on, and the whole given a coat of Hard Drying Carriage Varnish. When this is hard, it should be flatted down, and the fine lines put on.

The painter has now the opportunity of showing his skill in carrying out the design of the builder. All ornamental ironwork intended to take away any plainness should be brought out prominently with the lining. Some manufacturers do not like the sides of their chassis frames to have any lines upon them, as they consider they make the frames look too light, giving an appearance of lack of stability, whereas their object is to show a strong, bold chassis, capable of supporting the engineering and body-work. This, therefore, is in direct opposition to the style adopted in lining the horse carriage, where the coach-builder, in order to make the heavy parts where strength was required look light, used fine lines to give an appearance of lightness.

The engine cylinders and gear boxes should now have a coat of aluminium paint, or black paint, according to taste.

The chassis is now ready for a final coat of Finishing Carriage Varnish. Before this, however, special care should be taken in washing off, a free use of the water tool being necessary in order to successfully contend with the many dust harbouring crevices.

An extra coat of Hard Drying Carriage Varnish on the tank and dash, before the final coat, is advisable, when time allows, as increased brilliancy will then be given to these parts.

A word should be said as to the necessity of absolute cleanliness in the paint shop, both as regards the person of the painter and the shop itself. Floors, walls and roofs should be scrupulously clean, otherwise they are productive of much dust, besides which anything in the way of uncleanness tends to propagate the fly pest—the painters' abomination.

Ventilation, too, is of the utmost importance. The old idea of an air-tight compartment for the finishing room is an exploded fallacy. Pure air, and plenty of it, is as essential to the well-being of the varnish as it is to the painter himself. The heated air, with the varnish fumes, should be allowed to escape through ventilators in the roof or the top of the walls, and proper provision should be made for an inlet of fresh air from the outside.

Rotation of Painting.—

1. First coat of special priming.
2. First and second coats of lead colour.
3. Hard stopping holes, etc.
4. Five or six coats of filling up.
5. Guide coat of stain for rubbing.
6. Rubbing down.
7. Coat of finishing or facing lead colour.
8. Stopping and facing on finishing lead colour.
9. Three coats of colour, including varnish colour.
10. One coat of shiny black.
11. Two coats of black japan.
12. Three or four coats of varnish.

CHAPTER XXXVI

TRIMMING

One of the chief differences between a public service vehicle and a private one, and between a cheap and an expensive one is, the luxury of the interior trimming and the accompanying degree of comfort. The cushion and squabs used in trimming not only act as pads to keep the person away from the hard wooden structure of the body, but the materials with which they are built up are chosen with regard to their resilience and shape-retaining qualities. Series of springs form the foundation of most trimming work, over which is laid curled horse-hair.

Successful trimming, giving comfortable seats, depends greatly on the arrangement of the woodwork. If a seat board has been fixed in without any drop to the rear, the trimmer may counteract it by making the cushion thicker in front.

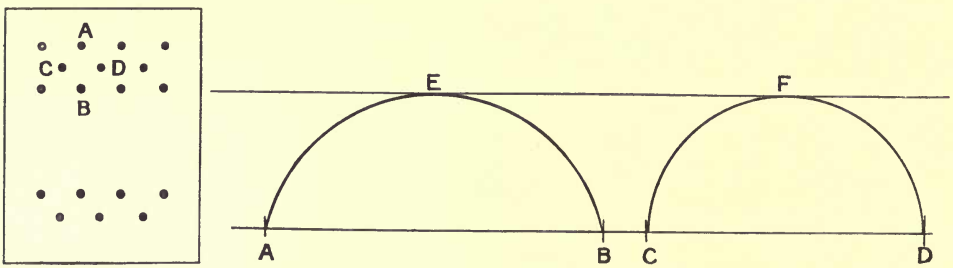
Squabbing.—Apart from designing a cushion so that it throws the occupant naturally on to the back squab, the squab itself must be shaped without any fullness lengthwise in the centre, so that the passenger is not thrown towards the ends of the seat. The vertical fullness must be constructed so that it fits well into and supports the back, and must be high enough to rest the shoulders, and, if desired, the head as well. Inside elbows should be low enough to form a comfortable resting for the forearm, and dropped at the rear to follow the inclination of the seat.

Where Padding is Restricted.—In trimming a body the whole width has to be kept within narrow limits, the side padding will not be squab, as at the back, while the treatment of the doors and the sides of the gangways will be flatter still, so as to give an artistic effect with the least possible thickness. Padding is not always confined to the position occupied, but it may be seen used above the elbow. This style is not recommended, and it must be admitted that the plain work above contrasts pleasantly with that below and harbours less dust.

Pockets.—The pocket formed in the trimming still continues in favour. If made up in the back of the door it generally lends itself to shabbiness on the side of the body, though in a long car it is perhaps in its best position. In the absence of folding seats on the lining boards a pair of pockets may be placed there.

Blinds.—Most closed cars are fitted with blinds, generally of silk (lute-string). They are rarely used by the passengers, and are a source of trouble, especially with a landaulette, and should be avoided.

One of the greatest difficulties experienced by a young trimmer is the marking out the correct amount of "fullness" for pleated squabs, but is easily found by the following geometrical method. First decide on the thickness of the squab; then measure between the buttons A, B, and C, D. Draw two lines parallel to each other, and the distance apart to be that of the required thickness of the squab. Mark on the lower one the distances between the buttons A, B, and C, D, then with a compass draw in curves touching points A, B, E, and C, D, F, then with a piece of string measure these curves, and the difference between the length of string and the distances marked on the lower line equals the required fullness; half diamond would be half the fullness. It is easily discernible that the further the buttons are apart the fainter the sweep; therefore the fullness is less; so this is why there is so little allowed in the long flutes of a back squab.



Coach-trimming Materials.—The woven coach laces used for fixing, covering and binding raw and concealing rough edges, and at the same time decorating carriages, are of three kinds. *Broad Lace.* Both single and double selvedge edges are used for display, purely ornamental, at times for valances, round the inside of roofs or front of seats; it is also used for finishing the edges of doors, arm or pillar holders, glass strings and falls. It is made in width $2\frac{1}{4}$ in. to $3\frac{1}{2}$ in., but $2\frac{3}{4}$ in. is generally used, and is sent out in pieces of about 40 yards. *Seaming Lace*, as implied by its name, is used to conceal seams in the lining when it is piped or corded. It has two edges, while *pasting lace* has only one tape edge, which is pinned to the work, the other part folded over and pasted down; its use as a decorative finisher is for concealing rough edges and tacks. These laces vary in width and are made in pieces of about 50 yards.

Binding, piping and *edging*, made of leather creased to match the colour of lining, is entirely used in all open-car work for finishing, the nails being concealed either by covered nails or polished beading. *Canvases* vary in texture for the work required: as "buckram" for squab back; Forfar, duck and brown hollands for the same purposes; twilletts for covering

seats; black duck for bottom of cushions; unbleached calico for seat casings and coverings. *Rexine* and *Pegamoid* are used in very cheap work for all classes of motor cars and carriages as a substitute for leather.

The best English curled horse-hair is used on account of its great elasticity, and has many substitutes. In a squab, where softness is required in the part that supports the back, the best white hair should be used; but in the top, where form and stiffness is required to make a "roll-over," it is built up with felt and cheaper grey hair.

All good cars have the back squabs and cushions made up on coiled springs (about gauge 15) to the required depth and kept in position by tying, lacing and webbing. By this means a great depth of squab and cushion can be got with increased comfort and resiliency. The woven mattress springs are commonly used. Some trimmers make their cushions up on a light frame made of wood, welled and the springs tied to them. In very cheap work millboards are used, and the springs laced to them; but, whatever form, the spring case is covered with a calico casing having a double top, which is stuffed with hair. Over this is slipped the outer cushion cover, after a layer of cotton wadding is put on top; the ends are then stuffed out, if required, to give them a rounded appearance. Floorcloth, linoleum, rubber matting, silk for blinds, plush and figured, tabourets, etc., for cushions and squabs, likewise the various tufts and buttons, etc., are also used.

Motor-trimming Materials.—The materials employed in motor carriage trimming are numerous in grades, colours, quality and variety, but the "motor hides" common to most bodies have by far the largest consumption. All kinds are supplied in unlimited shades and colours, not only in the dull, darker and more subdued shades, but also in the lighter and brighter ones, the grey, blues, reds and greens being the most common. The average size of a hide is some 58 ft. super., one method of measuring being to take the width 2 ft. up from the butt, and multiply the length by it, which gives the contents. The more accurate way is to total the widths measured at every 1 ft. space. A mechanical device, an "areameter," is generally used by the manufacturers. In selecting motor hides they should be soft, pliable, uniform in thickness and colour, with the grain regular throughout. The hides are sold as best hides, secondary (for taxi-work), with a third quality, and even a fourth, which latter are mostly continental leathers, generally a split leather with the grain rolled on it; they cannot be used for good work, as they cannot bear the pressure of pleating and tufting, and are mostly harsh, while in wet weather the colour is not permanent, and is known to come off, and also fly. In examining a hide see that the flesh is free from holes or cuts made from the knife dressing. The prime part is the butt after the belly and neck have been rounded off.

Enamelled Leather is used for covering hoods of all kinds; there are two sorts—the straight and the cross grain. In trimming a landaulette the grain of leather should run on top from side to side, on quarters vertically and

the back horizontally ; it then creases and closes together better. With cross grain it can be cut in any direction. Approximate price of these hides is 70*s*. Waterproof twills, of a variety of colours in fawn, khaki, etc., the best of double texture, consist of the two fabrics with the materials solutioned together, with the rib placed in opposite directions, diagonally, the quality and the amount of solution (rubber) used adding greatly to the weight and durability. They are made in widths from 60 in. to 72 in. and from 5*s*. 6*d*. to 8*s*. 6*d*. a yard run. Kamac is a substitute at 60 in. to 72 in. wide, and is from 9*s*. 6*d*. to 12*s*. 6*d*. a yard run. Baghide is used for covering wings and dashers of carriages and electric cars. Brown and black welting hides are thin split hides, and is used for binding and welting. Patent leather is used for valances, etc.

Cloths.—The best West of England coach cloths are about 60 in. wide. Wool dyed are the most durable and expensive. The "Seconds" or cheaper cloths come from Yorkshire, having a mixture of cotton, and are used for cheap work. Cloths are sold in pieces of about 32 yds. To test the strength a piece may be suddenly stretched over the two thumb nails, or cut with a sharp knife to see if the colour is the same all through and the texture uniform. Examine in a bright light to see that the texture is uniformly woven ; also burn a few threads in a flame to discover the amount of cotton used.

Coach Cloths should be soft, supple and supplied with little dress ; the pile kept short, and not rough, so as not to hold the dust.

Moroccos from goats' skins are used for the interior trimming of high-class close carriages.

Roans are from sheep, an inferior substitute, the process of tanning these hides being by the bark of the tree known as "sumach." The corded cloths known as French and Bedford cords are extensively used in trimming landaulettes, limousines, coupés, and the colours that are mostly used are grey and fawn in endless variety, and sometimes shot with blue, green, yellow or brown ; they are strong, durable, and most suitable for this particular work.

Carpets—Brussels, Wilton and French—are used for covering rockers, etc., and in good work the inside bottom should be covered with Brussels or Velvet pile, which, like all other carpets, should have its edges well turned in and bound, as their extreme coarseness in texture makes them liable to ravel.

Materials required for Trimming.—*A Side Entrance Phaeton* (torpedo pattern).—115 sq. ft. of motor hide ; 3 mattress cushions ; 1 gross of buttons ; 30 lb. of horsehair ; 4 lb. of wadding ; 1½ yd. of 40 in. carpet ; 1 dozen springs ; 2½ lengths of $\frac{5}{16}$ in. rough beading ; 2 lengths of ⅜ in. polished beading ; ½ yd. of plain linoleum ; 1½ yd. of black silesia ; 6 yd. of flax canvas ; twine, cord, tacks and paste.

Single Landaulette.—11 moroccos ; 6 yd. of cloth ; 4 yd. of carpet ; 36 yd. of seaming lace ; 36 yd. of pasting lace ; 3½ yd. of 2¼ in. close edge ; 6 yd.

of 2¼ in. broad lace ; 3 yd. of curtain silk ; 12 covered nails ; 3 mattress springs cases ; 4 glass strings ; paste, nails, tacks, linoleum, canvas, etc.

If trimmed in Bedford cord, 12½ yd. of Bedford cord, in place of moroccos and cloth.

2-*Seater Runabout*, with a rear folding dicky seat in tool case.—1 hide, approximately 50 sq. ft., 8 sq. ft. for trimming rear seat ; 2½ yd. of sail canvas ; 6½ yd. of wadding ; 4 yd. of unbleached calico ; ½ yd. of black duck for cushion bottom ; 12 lb. of horsehair ; 1 woven mattress spring for cushion ; 4 lb. of paste ; tacks, thread, webbing, and binding edging, seaming cord and tufting twine.

Materials specified above are for a body that is trimmed plain (no buttons required).

Limousine body.—6¼ yd. of cloth, or 14 moroccos ; 1½ yd. of head-lining cloth ; 5½ yd. of silk for curtains ; 2¼ yd. of cloth for glass frames ; 16 yd. of broad lace ; 50 yd. of seaming lace ; 40 yd. of pasting lace ; 2½ pairs of tassel holders ; 1 pair of frogs for arm-holders ; 1½ gross of buttons ; 9 yd. of black duck ; 5 yd. of buckram ; 1 yd. of Wilton carpet ; 1 yd. of floor cloth ; 24 lb. of best horse-hair ; 1½ yd. of cambric for curtain barrels ; 7 lb. of cotton wadding ; 2 lb. of seaming cord ; ½ lb. of tufting twine ; 3 mattress springs ; 1 pair of door stops ; 1 dozen ¾ in. brass screws ; 7 plated broad lace plates ; 1 ball of sewing thread ; 1 spool of machine thread ; 1 spool of machine silk ; 8 yd. of silesia or muslin ; 6 packets of tacks ; 6 lb. of paste ; 7 spring curtain rollers ; 2 arm-holders, 1 yd. of linoleum ; 1 hide of leather for front seat ; 1¼ yd. of duck for cushion bottoms ; 2 yd. of twill for roll-up curtains ; 7 sheets of plate glass to size.

Accessories.—2 pulls for door handles ; 2 card cases ; 1 hat rack ; 1 combination toilet box ; 1 bouquet holder ; 1 hand rail ; 1 ash and cigar tray ; 1 toe rail ; 14 window fasteners ; 2 umbrella holders ; 1 encased watch ; 4 coat hooks ; 1 parcel net ; electric indicator ; 4 dome lights ; interior bracket lamp ; 2 ventilators ; 1 electric cigar lighter ; electric battery.

All the above qualities of materials, etc., are for first-class work, and of course can be modified according to requirements.

CHAPTER XXXVII

CAPE CART HOODS

(*See* PLATES XLVII AND XLVIII)

NUMBERLESS varieties of Cape cart hoods are in use, fulfilling the special requirements of owners, but really all can be considered either as the single or double hoods with front extension slats, or the double extension hood entirely operated from the hind part, which latter may be fitted with three, four, or five and, in specially long bodies, with even auxiliary sticks.

The subject of this chapter is not the best or most suitable style, but the method of putting up any or all hoods in a workmanlike fashion. After taking the measurements for the hood, as explained further on, the sticks or slats are ordered from the wood benders. They are sold at per foot (price per set). No more length than is absolutely necessary is ordered, the front and back stick being a trifle under the uniform thickness generally supplied by the trade.

Previous to putting up the hood comes the fixing of the iron work, which should always have stout flaps carried over inside the body (see Plate XLVIII), the hood having possibly to clear the roll over top. In some bodies the slat irons to carry sticks may be bent outwards, thus avoiding the use of a long projecting stay.

After fixing the ironwork, see that it lines crossways and upwards, that the slat irons are true, free from twist and fall nicely into their place. The body flaps and stays, where possible, should be bolted rather than screwed.

Assuming the ironwork is fitted, and that we have a, say, four-stick hood for a side entrance (a general pattern), the front when down is taken by a slotted eye and butterfly nut. We proceed by putting up our centre stick, or the two middle sticks; that will give us the total height, say 3 ft. 4 in. from top of cushion. Before separating the sticks from wood benders, it is as well to mark the centre and square it all over the sticks and set a distance each side some 14 in. or 15 in., and square that over as a test line in measuring the parallelism of sticks to the body.

In the four-seater we have put up our rear seat stick, which is probably square, and the one behind the driver, so to have about 1 in. sail back, and with a light screw fixed temporarily; we now fix the back stick, giving the necessary round or drop for the curvature from front to back, also a sail over the back of 2 in. or $2\frac{1}{2}$ in.; after which we fix each stick—to line

PLATE XLVII.

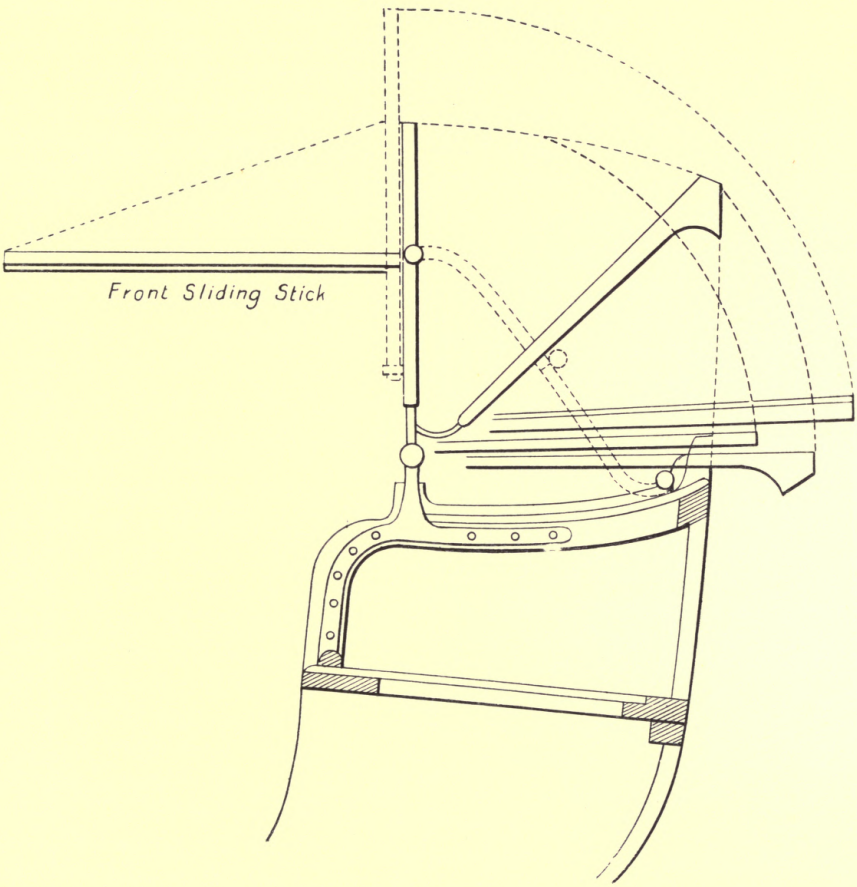
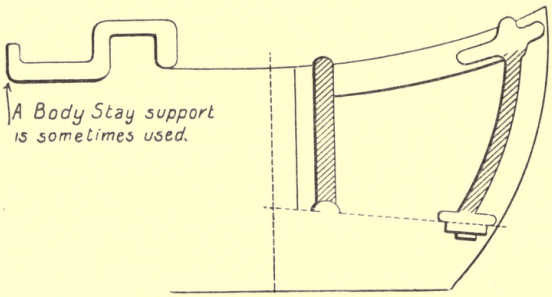
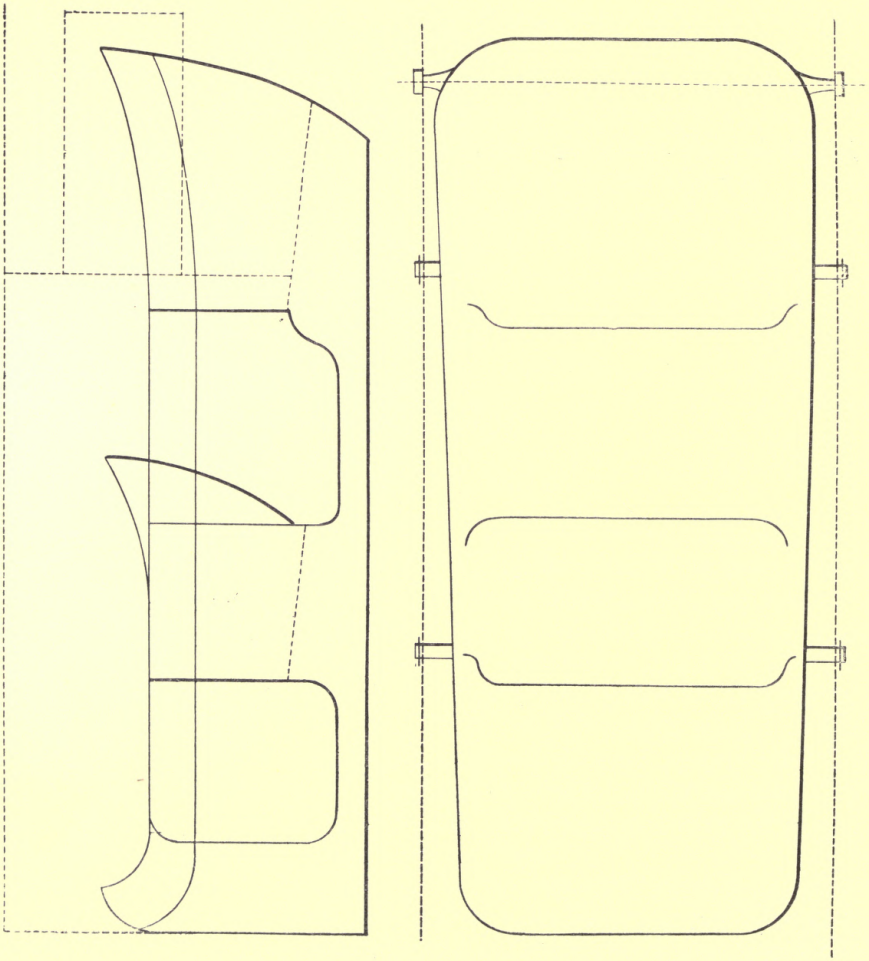


PLATE XLVIII.





it, dropping it down and measuring from the points marked from some part of the body, also cross lining it and well righting the same, as to improve the appearance one may have to go up a screw hole, or another down. All being temporarily fixed and held in place by webbing, the hood is lowered altogether, and tested for the right clearance between each stick, not less than $\frac{1}{4}$ in. being given, or more if desired for a special fitting. Everything being satisfactory, all holes are marked in slat iron, the end of sticks regularly marked off for length, the sticks are taken off, the ends rounded and the sticks cleaned up with all sharp edges rounded, then they are ready for polishing or staining, after which they are varnished, and finally fixed to the fittings, which may be painted, wrought iron being filed or all over brass or nickel-plated, as the case may be. If outside stretcher joints are not used, straps secure the front hood when up. If all is right the hood is now ready for webbing corners and passing on to trimmer.

The measurements for a hood should embrace the following :—

Head room required.

Depth of body sides at both seats.

Width across body at bracket fixing over the collars, with allowance for the clearance, giving width inside of sticks.

Length over all.

Shape of corners so as to coincide with body framing.

Contraction, if any, rarely given.

Method of fixing finger plates inside or out of sticks.

Dimensions of each stick in width and thickness.

Length of stick required.

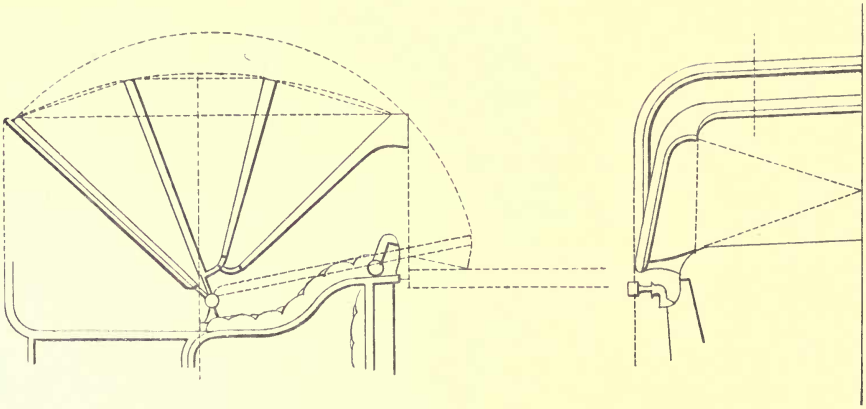
Width across back and front seats and across centre of head rest.

With the above remarks in your mind you can easily follow the dotted lines in Plates XLVII and XLVIII.

Victoria Leather Hoods, with or without Outside Head Joints.—The method of putting up hood, fixing slat irons and getting the fittings follow in this type of body as in the Cape cart hoods ; the accompanying sketch shows the methods of testing, also the variety of outside stretcher joints that may be used. When there are no spring lifting agents the head must be bound firmly into its position, and the sticks in so doing may be moved a little either way to suit the eye of the line of curve and the angle of the front and back sticks, all the sticks being up and set with the requisite pitch and the sail of the back as seen in the two seater, in which the back stick is made with a square corner.

The lining of the sticks is shown in Plate XLVIII with the method of squaring off to form the corners and fixed points. The front is lined with the dash transversely as a square point. The back slats are also lined with the body framing. While keeping to the measurements, hoods should be fixed up so as to satisfy the eye, especially in a curvilinear body. The hood is now ready for the smith to take the length of the joints. The

elbow props and top prop nuts should be fixed some 6 or 8 in. down, keeping them, as a rule, as high as possible. These points being fixed, we proceed to take the length of the joint by straining a wax line (having a loop at each end) round the cylindrical ends of the props. The head is then opened or struck to the position it is intended to occupy, making due allowance for the cloth and leather, or twill, or other fabric used in covering. The wax line is then doubled to an angle, lining with the slats, keeping the upper part of joint parallel with the face of front stick, a marking awl holding the corner taut ; a piece of string can be tied in the angle. With double joints the practice is followed from each pair of prop nuts. The wax line is now straightened out on a piece of board fitted with pegs the same size as the



props, and the smith shuts up his joints accordingly, having the joints a good $\frac{3}{8}$ in. or $\frac{1}{4}$ in. longer than the wax line, so as to strain the head tight, and to impart firmness and the necessary set or support to the joint, and so obviate any liability of dropping. This string method is the general way of taking the length of joints as to centres, whatever may be the shapes, though with standard types of bodies iron stretchers with set-holes are frequently used. Straight joints require great accuracy in fitting, so that they line when up and set nicely when down.

Swept shape joints are easy to fit, for the compass may be taken out or put in, as the case may be, with no trouble. All joints should give the " nip " to the head that will set it firm when the covering is on. The size of joints used are $\frac{1}{2}$ in., $\frac{5}{8}$ in. or $\frac{3}{4}$ in. All leather hoods should in front be finished with a valance either of wood, metal or leather, or combination of these materials. A good finish in front is made by fixing a wood valance, and covering the same with the best border leather with a $\frac{3}{8}$ in. metal bead in the centre.

Landaulette and Landau Hoods.—Apart from the details already mentioned, there are one or two important points that it is necessary to emphasize and to make clear for good results and a perfect fitting hood,

The substance of the pillar tops and cant rails are in accord with the lower framing according to depth shown on drawing, being mostly cut from 2 in. to $2\frac{1}{2}$ in. plank; the pillars are rebated $\frac{5}{16}$ in. for frames, if supports are not used, and the four slats mostly used are cut from $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. ash, worked up $1\frac{1}{8}$ in. or $1\frac{1}{4}$ in.; the hoopsticks are $1\frac{3}{4}$ in. by $1\frac{1}{8}$ in., notched and screwed to the slats from the top with two screws, the whole of the corner being canvased. The pillars in a light landaulette are frequently finished $1\frac{3}{4}$ in., shaped to the top half of hinge pillar, so that all is level inside for the trimming. Most folding hoods are said to be automatic; that is, they depend for their action on the use of spiral springs working either by compression or extension. The main differences in many instances exist in the turning of the cant rail, and the foreshortening of the hood when it folds, so that outside head joints are dispensed with, and that the head may be opened from the inside when the car is running. The connexion of the inside joints with the cant rail renders it then to some extent self-acting. In the mechanism of a good head lift, the springs are enclosed in tubes working telescopically. The application of the spring is varied with most makers, some working up the pillars, some above and some below the elbow, some at an angle and others horizontal, but all having the one desired object with various connexions at the top end of the spring. A great point to study in all spring heads is that the lower axis of the tubes containing the springs must lie in a parallel direction to the pillar when the head is down; this will reduce the power required to lift and also the liability of the head to rise when the car is at work. Cost, weight and simplicity of mechanism, and accuracy in working with the least amount of exertion are the desiderata of these head fittings. In fitting up the heads, be sure that the cutting off of the pillars is in a perfect line with the door rail. The door rail should always be made equivalent to the space occupied by the slats and pillar top, when down, so that the whole is as flat as possible, without the thickness of the folding pillar standing above the hinge joints. Only those hinges should be used that will allow of this, and therefore give a straight line from the door fence rail.

When the hinges are fitted the folding pillars are cut to the length, the cant rail fitted and boxed out for glass frames. Accuracy and the squareness in fitting, as before mentioned, is important, so that when up or down the cant rail is thrown out or folds all in a line. This completed, the thimble catches. Cup, ball or other fittings used to draw them into place may be fixed. In pronounced cabriolet bodies it depends on taste and possible requirements, and also the type of body, as to what amount of droop from the centre to the back and the front and the upward curve of the hoopstick without touching, but in an ordinary landaulette it may be taken as a rule that the centre of the head slats should not curve more than $1\frac{3}{4}$ in. from the centre to the end slat, and should not curve more than $1\frac{1}{2}$ in. to 2 in. on the top.

CHAPTER XXXVIII

WIND-SCREENS

General directions for their arrangement and fitting. It is outside the province of this chapter to advocate any particular type of wind-screen, for all have more or less of the many advantages claimed by the makers. The several patterns now on the market relieve the bodymaker of its selection, which is more often decided by the owner when ordering. Notwithstanding, it is important that the bodymaker should thoroughly understand the proper functions of a screen in order to avoid the faulty application, unsound mechanism and a wrong principle frequently seen on otherwise high-class work. The utility of a screen is, of course, comfort and the complete protection of the occupants, especially on the front seat, from all back draught, wind, dust and rain; and these results must be obtained without in any way obstructing the view of the driver in bad weather.

The screen in its fixing must be firm, rigid, neat in appearance, light in weight, free from rattle, and easily adjusted when the car is running, and frequently special requirements are needed, if the car is to be exported. Wind-screens, though of many patterns, may really be classified under the following headings :—

The upright plain single screen, rigidly fixed to the dasher or behind front seat;

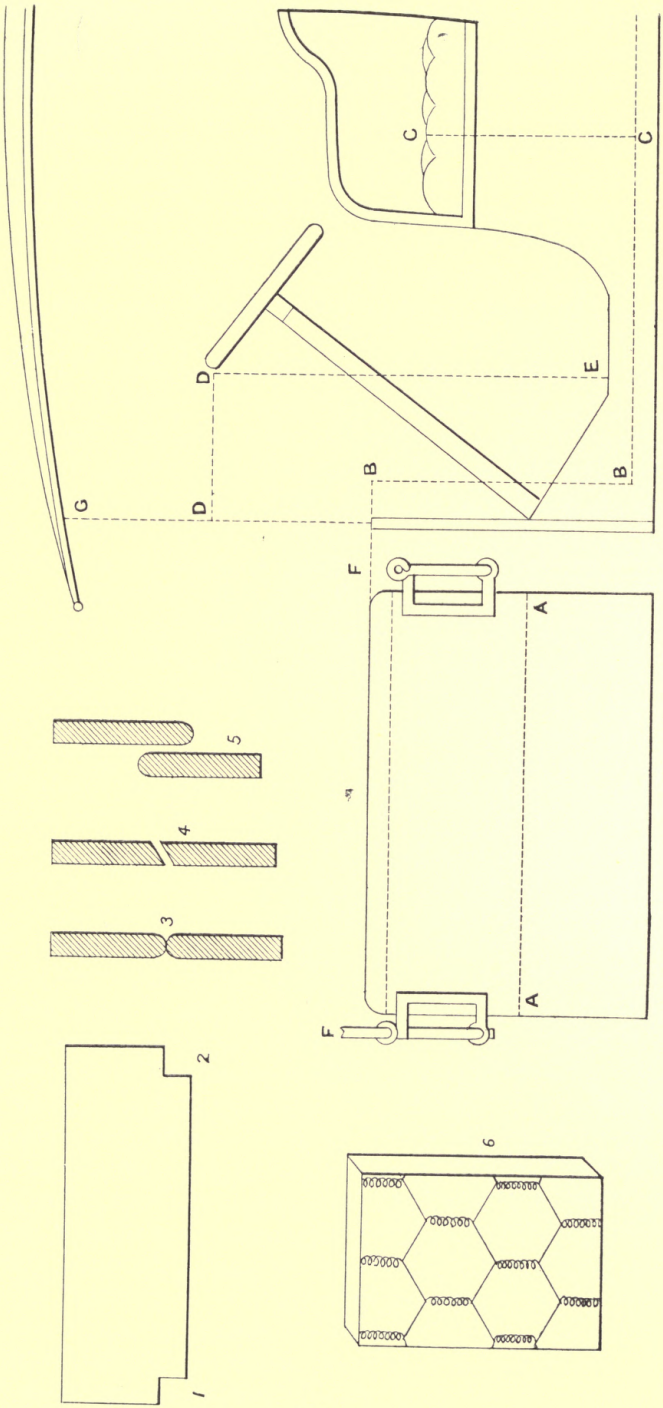
The single-folding upright, or fixed at an angle and made to fold or revolve in any direction;

The double-folding or triple-folding screens, with deflecting glass panel that can be adjusted at any suitable angle;

Special types of screens to fit dash with swept panels; and screens are panelled with other materials than glass (as frequently on the Continent), consisting of an iron frame covered with canvas or enamelled leather at its upper or lower part. Screens for cars for hot climate are frequently of wire gauze. Screens are also panelled with polished plate, with wire imbedded, as at No. 6 (Plate XLIX), for safety, as also are screens of the "Vene Triplex," which is a triple substance of glass, celluloid and glass, the object being, of course, in case of an accident there will be no cuts from broken glass.

In fixing the screen and deciding on the dimensions of the folding panels, be careful to arrange for the diversion of air currents, by different adjust-

PLATE XLIX.



ments, in order that all moisture should disappear quickly, thus giving a clear view through the panes. In a car for India wire gauze should always be fitted and kept low enough to enable the occupant to see the road ; the top edge is kept 18 in. to 20 in. from the driver's face, so that it breaks the wind with no back draught ; but if kept higher, then an open mesh is required for driver to see through. The mesh in common use is 36 to the inch. Measurements, of course, vary for different bodies, but for an ordinary torpedo body, with hollow dash, approximately 4 ft. over all, all reasonable demands should be met by a standard size with a depth of top frame from 12 in. to 13 in., with the folding deflecting frame 6 in. to 8 in. deep.

A limousine body frame varies from 3 ft. 8 in. to 3 ft. 10 in., small single screens 3 ft. 3 in. to 3 ft. 6 in., rarely less than 3 ft. 4 in., or otherwise the many advantages are lost. The sizes of the walnut or mahogany wood frames should be $1\frac{3}{4}$ in. by $\frac{3}{4}$ in., supported by $\frac{3}{4}$ in. half round or $\frac{5}{8}$ in. stanchions, to which they are fitted and sometimes clipped, or working entirely in a metal frame.

When the top frame is made to swing, with a metal frame all round, the rails may be kept $1\frac{1}{8}$ in. wide. The best joint in making the frame is the mortise and tenon, and to ensure the tight fitting of glasses, especially with open end frames, the shoulders should be cut slightly bevel to bring the frame $\frac{1}{4}$ in. in on top, so as to cause a nip. However strong the windshields, stays and brackets may be, and however well fixed, vibration and rattle will set up if the dash be not rigid, and if it is at all on the weak side it should be stayed by a stout bracket, which may be fixed or adjustable, especially when, as frequently happens, the lamp bracket may be in the solid. The complete fittings are now supplied, leaving little or nothing to the body-builder beyond the fixing, though it is the common practice of many bodymakers to make and fit their own screens, making their own ironwork and often all fittings, having them all over brassed, close-plated or nickelled, and thus screens are made at once suitable for the job in hand. In doing this it is as well for the bodymaker to remember to have the fewest number of parts or any complicated mechanism ; to see that the adjusting handle is large, easy to move, and that the ironwork has sufficient strength, so that the screen will stand up against wind pressure, and not eventually set up vibration by parts working loose. As to the various fasteners, silences, channeling and other fitments required by special body work, their construction is simplicity itself and attachment self-explanatory.

Fitting up Bent and other Glasses.—It frequently happens that trouble is found by the bodymaker in putting in bent glasses so that when fixed and at work they will not "fly" or fracture. The causes of fractures in many cases are that the rebating on the framework is not true, that the framework is not rigid and works slightly, that the glasses are unevenly bedded, thus causing unequal pressure on the fillets.

Taking the bent corners in landaulette with D-front, I would insist on a plate $\frac{3}{4}$ in. half round up on the inside of the pillar with a flap along top bent corner. The glasses should be put in from the inside, not out; to keep the water, etc., away. The framework is then fitted round to the glass, so that it lies dead home and there is no movement in any corners and no spaces can be seen from the outside; the fillets are then screwed in, after which the glasses are removed, and the frame painted round the rebates. In final fixing, cover the edges with thin sheet rubber, paint the framework with a coat of gold-size, take two hand-shavings off the fillets, and screw into place. The draw on the screw-holes gives sufficient pressure on the rubber to bed the glass, and when all is hard and dry, clean off the gold-size that squeezed out with a sharp bevelled-edge chisel. This is more effectual than putty or red lead, etc., that only work out cracks, etc., and, what is more, running vibration in the car will not have the least effect on glass bedded in this manner. The frames are jointed with slip, mortise and tenon, but to ensure that glasses which have an open end are tight, the shoulder should be cut slightly bevelled, as already stated.

With patent folding frames, either for front or back, special instructions are usually given as to the fitting. The patent or invention itself usually consists only of the attachment, locking or adjusting arrangement, and an individual can make without fear any type of shape, whether to slope or to fold, using his own idea as to securing the same.

Patent fasteners, metal channeling, metal moulding are frequently used for lightness, strength and rigidity, while telescopic stays with swivel joints are often utilized to prevent cranking the stays. The metalwork, as a rule, is polished all over brass or nickel-plated, "not electric."

In regard to the glass, the best polished plate-glass is used, about $\frac{3}{16}$ in. thick. The sketch, 1 and 2, shows the corners notched to keep the squares fixed in the frames; 3, 4, 5 show the treatment of various edges. The curved polished plate, $\frac{3}{16}$ in. thick, is, as a rule, about 6*d*. per foot more in price than the ordinary glass used. In very cheap work glass known in the trade as 26 oz. or 32 oz. is sometimes used. When glass has to be bent to the frame or patterns, as for D-front, it takes six or seven days before the glass is properly annealed after bending.

I have already mentioned about glass, celluloid and glass combined. This kind is on the market and is known as the Triplex Safety Glass. It is quite a new departure and is a great boon for the motor car, where it has many applications for the wind-screens and windows.

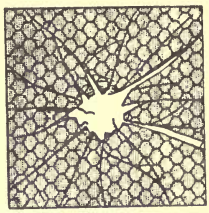
The principle upon which this glass is made is strikingly simple. A sheet of specially-selected clear celluloid is placed between two sheets of plate-glass and the three sheets, after a patent treatment, hydraulically pressed together. Owing to the tenacity of the celluloid, when the glass receives a heavy blow it merely bulges out, and "stars."

The following sketches illustrate a test which the makers put this glass

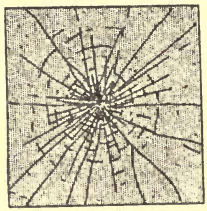
to, and shows its usefulness for motors, etc., thus minimizing the danger of cuts in case of accident.

A sheet of the Triplex glass was placed in a frame and mounted vertically. A round iron ball, weighing 2 lb., was suspended on a cord 15 ft. from the ceiling in such a way that, when released, it struck the glass fair in the centre. The force of the blow, it will be fully appreciated, must have been very severe. Nevertheless the Triplex glass was not punctured, it merely bulged out approximately to the shape of the iron ball on the other side of

(1) Ordinary Plate glass.



(2) Armoured glass with wire imbedded in it.



(3) Triplex glass.

the glass. Moreover, the glass, although actually fractured or "starred" into a great many pieces, did not splinter or fall away in the least.

The same test applied to ordinary plate-glass completely shattered it, and in a case of a test made with the wire imbedded glass, the suspended weight drove a large hole clean through it, some of the pieces of glass being scattered a considerable distance. The celluloid, being hermetically sealed between the glass sheets, cannot possibly tear, and remains as permanent as the glass itself. It is well known that unprotected celluloid very soon discolours, becomes scratched, and rendered inefficient for the purpose of a screen. Moreover, there is the well-known risk of fire, celluloid being extremely inflammable, whilst the Triplex sheets are perfectly fireproof. An interesting fact, which shows the great tenacity of this glass, is that it can be cut on both sides with a diamond without parting, and to cut it a special process has to be adopted. The sheets can be had in any colour.

CHAPTER XXXIX

FRENCH POLISHING

A NEW department which has been added to many motor-body building firms is that of French Polishing, in which are treated the glass frames, tool and accumulator boxes, and the undersides of roof extensions, inside folding tables, wind-screen frames, fillets and other items.

The Filling Up.—The woodwork to be treated is glass papered off with No. 1 paper and dusted off, after which it receives a coat of filling up made of plaster of Paris as a base, linseed oil or tallow as a spreading medium, and some burnt umber or polish to stain it to the tone required. Rose pink is also used as a colouring medium for mahogany work, while yellow ochre gives the necessary tint for ash. This filling up is rubbed on with a rag and allowed to dry, and if the wood is an open-grained one, such as will occur in a whitewood tool box, the process is repeated. The filling up is glass papered off and a coat of raw linseed oil applied, well rubbed in, and the superfluous oil wiped off and allowed to dry thoroughly for at least two days.

The coats of polish now follow. This is bought in gallon or half-gallon jars, from which it is poured for use into an old wine-bottle which has been properly cleaned and dried. In one is placed some white polish, and in another the polish having the familiar reddish brown tint.

The Cotton Rubber.—The polisher's chief tool is a pad of cottonwool bound in muslin or other clean cotton rag, the loose ends of which are grasped and the whole used as a rubber.

The polish is not applied to the rubber from the outside, but to the wool inside, and allowed to percolate through during the process of rubbing. The preliminary floating coats of polish may be either, say, four alternate rubbing of each kind of polish, or only a coat or two of the white polish towards the end of this first stage. The rubbers are kept in tins, with tight-fitting lids, so that they may be kept moist. The next coat of polish follows with another rubber, after the first coat has been faced down with glass-paper. A third rubber is also now required, which is moistened occasionally with a little linseed oil. This oil is used to prevent the polish pad sticking to the work, but only sufficient oil should be used to keep the polish pad moving freely, for any excess will create a want of stability in the final

coat which follows. This coat may be repeated for good work, after which the papered, dusted and oil-freed surface is given a very thin and light coat of polish. The oldest rubber, made of the closest woven muslin, makes the best pad for this stage of the work. The polish should only be just damp, which is more easily attained, up to a certain point, when the pad by continual use has the pores of the material clogged with extremely fine particles of the solid matter in the polish, and fluffy portions from the wool inside and from the wear of the muslin cover. As a rule, the coats of polish are of shorter duration as they proceed, and a circular motion is indulged in where possible. About 65° Fahr. is the best temperature to work in, and the air should be as dry as possible, which condition agrees with the ideal atmosphere of the paint shop.

CHAPTER XL

STORES, AND HOW TO KEEP THEM

THE stores, which is one of the most important departments of the business, should be under the control of a man who is practical and conversant with the various branches of the trade, and he should be able to keep the materials, etc., up to the requisite standards both in quality and quantity. If the firm should specialize in any particular branch of the trade which necessitate a demand on certain fittings, materials, etc., such goods should always be well stocked sufficiently, so that there is no fear of "running out" before a fresh consignment can be received; of course, this applies to all the stock. A storekeeper should also have the qualification of being able to purchase goods at the proper markets, at their current value, and have a thorough knowledge of the required qualities and methods of arriving at them. The stores, to be kept to that standard of efficiency, must be governed by a systematical set of books, showing EVERY transaction of receiving and issuing of the materials. The books that are usually used are—

1. Order book. 2. Stores received book. 3. An invoice book.
4. Stores issued book. 5. Stock book and ledger.

Order Book.—In the order book the pages are perforated and numbered, being separated between each leaf by a plain sheet on which a copy of the order is made by carbon paper, the wording of the order is as below :—

LONDON AND COUNTY MOTOR WORKS.

Order No. 234. *January* 1, 1913.

To Messrs. Cox & Sons.

Signed.....

When the firm receives this order, and the whole or part of it is ready for dispatch, an advice or delivery note is sent to the customer informing him that the goods have been, or are being, forwarded, the goods being detailed on the note, or instead of this an invoice (*pro forma*, or account) is sent.

Stores Received Book.—When the goods arrive from the warehouses they should all be checked by the advice note or invoice, and entered into the stores received book in the order received. This book is ruled in the following columns :—

Name of the Firm.—This is the name of your own firm.

Date.—Date of receiving goods.

Number.—Number according to your ORDER book.

Manufacturers.—Name of the merchants.

Price.—Price as per invoice.

Discount.—Discount allowed by the creditors. In this column should be entered "net," or the usual $2\frac{1}{2}$ per cent. for monthly account, or the arranged discount.

This book is of great value, for you can always find the totals of all goods purchased between given dates, for this is necessary in making out the weekly or monthly accounts.

Invoice Book.—On receipt of the invoices they are put into the invoice book, which is alphabetically arranged and indexed, therefore the price and quantities can be referred to and also, when the monthly accounts are received, they can be readily checked and any mistake can be verified.

Stores Issued Book.—Now that the stores are ready for issuing the materials, they must be distributed with such a system that every screw, etc., can be accounted for, and this can be done by a methodical order of posted distribution.

When employees require any materials, they must obtain from their foreman or charge-man a "REQUISITION ORDER," giving an order for a stated amount or quantity of goods and materials for a certain job, which has a job number, also the date, and is signed by him. Sometimes these forms are of different colours for the various departments, which facilitate the collection and sorting out of them for booking purposes. The usual wording of the order forms is as follows :—

LONDON AND COUNTY MOTOR WORKS.

DATE : *January* 1, 1913. Department : TRIMMING.

REQUISITION ORDER.

Quantity.	Materials required.

Received by.....

Issued by.....

Signed. (By foreman.)

These orders are copied down by the storekeeper in the *stores issued book*, and afterwards they are kept for a period, in case reference should be necessary to see by whom the goods were drawn.

Stock Book and Ledger.—The ledger and stock book are both arranged alphabetically. In the *ledger* is entered all the material that is used, and the *stock book* gives the entire quantities of stock on hand, and its value at a *given* date, therefore in making comparison between these two books the amount consumable between certain dates can be ascertained. If all these books are kept in a correct order, and under strict observation, there should never be any complaints of being out-of-stock of any article when it is required. The storekeeper must have such experience and foresight so as not to overbuy, which is a bad policy from a business point of view, owing to the fluctuations of the markets, but circumstances and discretion are the most practical guidance for this.

Location and Construction of the Stores.—All *stores* should be conveniently located both for storekeeper and workmen, and in close proximity to the workshops, and they should be kept classified according to their nature. For instance, if there should be a garage or engineering section in connexion with the business, naturally there are oils, grease, etc., to be handled, and although the greatest care may be taken, it would not be wise to have the trimming materials, such as expensive silks, cloth, laces, etc., in the vicinity, especially as in the motor trade so many of these materials are of a delicate shade and fabric.

Also there is the timber to be considered. This must be put in such a place so that it can receive the necessary draught for continued seasoning. The *general stores* usually contains all small materials such as screws, bolts, springs and other ironwork, painters' materials, colours, etc. The *trimming stores* should be in a "divided" part of stores.

The storekeeper must know where to put his hand on anything at a moment's notice, therefore all goods must be systematically arranged. All screws, bolts, nails, gimp-pins, tacks, etc., should be put in pigeon-holes and their sizes or gauges and other particulars marked on the facia board that runs along the bottom of each recess, and be so arranged that the sizes are in graduated form. All locks, butts, files and other fittings, etc., are stocked in a similar way, according to their sizes, and so situated that they are easily procurable.

The painter's dry colours are kept in nests of drawers and in "a dry place," while the tins of ready ground colours are placed on shelves. All the inflammable materials, such as varnishes, turps, oils, French polishes and vegetable black, should have a special place set aside for them, where the temperature is such that there is no fear of over-heating, and a sharp eye should *always* be kept upon such goods as vegetable black, etc., where there is danger of spontaneous combustion.

Such things as manufactured or partly made ironwork or small forgings,

etc., can be hung on hooks or bars fixed to the roof, especially in the motor trade, where there are so many articles that can be hung up out of the way. In receiving and issuing materials, scales, weights and measures, are a necessary equipment of the stores, also a weighing machine should be in a convenient place near the entrance, so that all heavy goods can be checked on receipt, according to the delivery note.

The Timber Stores.—The timber should be kept in a place where there is a good draught, but it must have proper protection against sun and rain. All planks should have separating sticks between them. The place should be large enough to give plenty of room for going over and checking it. All the various planks, boards, pines, three-ply, etc., should be placed in timber stages or racks, and by so doing it will prevent undue splitting. As the timber comes in from the merchant it should be checked carefully and all planks, etc., measured to see that they agree with the delivery note. The smith's iron bars, and also the metal sheet for panels, booting, shields, etc., in their varying sizes and gauges and lengths, should either be stacked endways or racked, and by some method be distinguished, stating the sizes and particulars of same. A dry place is preferable for the storing of the ironwork, but it is not absolutely essential if there is a quick demand for it, so that rust has no time to eat into the surface of the metal.

The Trimming Stores.—The stores must be situated in that part of the factory, where the least amount of dust can reach it, owing to the contents being principally of such a nature that dust would deteriorate the goods, besides harbouring moths. Therefore it is necessary that all expensive silks, etc., should be kept in a clean and dry place. The cloths, serges, etc., which are usually in large quantities, sometimes over 70 yds. in length (and therefore very heavy and bulky), should be kept on shelves or benches, where they can easily be lifted off on to the bench where it is cut off into the required lengths. These large rolls cannot be placed in drawers, owing to the weight and awkwardness of handling same, but in small quantities it is most preferable to keep them so ; while if stacked endways on the bench or shelf care should be taken that the material always stands on its selvedge edge, so as to avoid damage to its centre fold. Buttons, tufts, straps, laces, guard-strings, rosettes and all interior fittings, including the sheets of celluloid, are kept in suitable drawers. The various canvases, American cloth, pegamoid, Japanned moleskin, linoleum, floorcloths, rubber sheeting, waterproof, twills, etc., are stacked endways in some convenient corner or recess of the stores where readily accessible and held in position by some suitable bar or fixing. All hides should be hung up on poles, and not kept rolled, as the enamelled side is likely to be damaged by being in contact with the backs. The temperature of the stores where the leather is kept should be moderate, owing to the possibility of the enamel cracking if the place is too cold. Morocco skins can be rolled up without any fear of being damaged, but no weight must be placed on them or they may be irreparably

creased. As room is a great consideration in most shops, all available places and niches must be utilized, so that the stores are kept to the smallest convenient size. Under all benches the spaces should be fitted with drawers and shelves in which the small stock already mentioned can be stored, and on the floor shelf all heavy stuff such as tins of paste and solution, dyes and revivers, coil copper springs of various sizes and gauges are kept. There should also be a good dustproof cupboard in which all the morocco-covered companions, card-cases, ash-trays and other delicate interior fittings are packed. A cupboard is more suitable for this class of goods, for if drawers are used there is the possibility of them being damaged in more ways than one, such as the closing of the drawer, as if it should be a bit tight it would cause a general friction amongst the contents, also other heavier articles may be laid on top which might also cause damage, which would not be likely to be the case in the cupboard with the shelves sufficiently apart to take the fittings, etc. The various horsehair, such as the best, seconds, and common white, grey or black are all clearly labelled as to their qualities. Being mostly in bulky bags of 56 lb. it would take up valuable room in the stores, therefore it is chiefly stored in a dry loft or some shed which may be too dark or inconvenient to work in, but useful for this purpose. Finally, there should be a place for everything and everything in its place. Above all, such a method that clerical work is reduced to a minimum, and that no loss be experienced by depreciation or things being out-of-stock; or, on the other hand, that the store is not overstocked with goods not required or consumable. This should be a characteristic which a storekeeper should cultivate and encourage by strict observation of his books, thereby running the stores on the most economical basis.

PRIME-COSTING

Importance of Prime-costing

The writer thinks it would be advisable to put in front of the reader the following Prize Essays to the Worshipful Company of Coachmakers, and reprinted by permission from the *Automobile and Carriage Builders' Journal*. I have taken the liberty to append a criticism to each.

ESSAY No. I.[1]

The question of prime costs has come to the front in all manufacturing businesses within the last few years, and in none more so than in the motor-body building industry. The chief reason for this is that competition has become much keener, and manufacturers have come to the conclusion that it is essential, if they are to hold their own and secure orders, that they must cut prices as low as possible, consistent with obtaining a reasonable margin of profit on the capital they have invested in the business. To be able to

[1] By Mr. Charles D. Roberts.

do so without risk they must know exactly what the articles they are manufacturing are costing, from the moment the inquiry is received until it is delivered to the customer.

Correct prime costs will ensure correct estimates.

In businesses where the goods sold are made in large quantities exactly alike in every detail, costing is a comparatively easy matter, but with the large number of departments embraced in motor-body building the task is much more difficult. The productions are so varied that it may be said that scarcely two orders are alike, although this has been to some extent remedied since the introduction of motor cars with their standard bodies. Those firms who have secured contracts for a fair number of bodies of uniform type have been able to reduce costs by making them quickly and buying materials in large quantities. Orders of this kind, however, are becoming scarcer, as the motor industry has levelled itself down, and buyers now are content to take just what the chassis builders like to supply, but insist upon having a voice in the selection of the carriage work.

Whether a man orders a body from the people who supply the chassis or comes direct to the coach-builder he generally requires a drawing prepared, and a specification submitted before finally settling the order. He has many fads and fancies which have to be gone into very carefully, and it is of the utmost importance that the coach-builder should be able to estimate almost to the exact farthing what the body will cost to build, and he will find that the actual costing accounts of other vehicles will be of great assistance to him in framing his estimate, and will help him to do it promptly, and probably secure the order while the other man is trying to find out what he should charge. It is dangerous to adopt a practice of cutting prices without a full knowledge of the cost of production, besides being a most unfair form of competition, and the man who does it richly deserves the fate which will inevitably overtake him. The drawback, however, is that he will do a vast amount of harm while he lasts, especially if he has been in the habit of extensively advertising his cutting prices.

It is of little use making one job pay if you are losing on others. Every transaction undertaken should bear its fair rate of profit. There are times, when one has to take a job as a sample order or to tide over slack times, when it may be a good policy to work at a little over cost, but even then it is as well to know exactly what the cost is, so that one may know exactly how far to go. Businesses are established to make profits, and accurate costing is the only reliable means of knowing that this is being done.

It is only the properly organized firms, managed by energetic and up-to-date methods, who are able to fight not only English but foreign competition, and proper organization and costing go hand in hand, and the lack of them has been the cause of many businesses going to the wall, although it is generally put down to bad trade or bad luck.

A man knowing that his work will be checked will work economically.

It, therefore, behoves every motor-body builder, whether in a large or small way of business, who has hitherto been lax in the matter of prime costs, to look about him and inaugurate a system suitable for the needs of his concern. It should be possible to have a standard method of working out costs on a basis which would be applicable to all, subject to slight alterations to meet individual requirements. If a system is worked out and adopted, and strictly adhered to, it will tend to reduce the cost of production, as every department, knowing that the detail of work will be carefully checked, will endeavour to work as economically as possible. It will help to cut down waste of materials, and it is no exaggeration to say that many pounds sterling may be saved annually if little matters of waste are detected and immediately checked. It is a mistake to look upon the costing staff as a department of expense only, as the statistics compiled by them, intelligently handled, are the basis upon which the future business may be founded.

The main objects in recording prime-costs may be summarized as follows:—

(1) To obtain the exact cost of production in order to know what profit each transaction bears.

(2) To ascertain the price at which a motor-body from stock should be sold.

(3) To obtain a complete analysis of the cost, showing exactly what labour and materials are used in each department.

(4) To obtain and retain reliable information for future reference for estimating.

(5) To detect waste, both in materials and labour.

(6) To act as a check on managers and others in authority.

What Prime Cost is.—The items which constitute prime-costs may be defined as follows:—

(1) The actual cost of labour, i.e. direct labour, which can be charged up to each job.

(2) The actual cost of materials which can be charged up directly to each job.

(3) Shop expenses and general working charges which cannot be debited to the cost accounts directly, but which are incidental to production. These include the wages of foremen, storekeepers, labourers, etc., whose time is not taken; the cost and upkeep of plant and tools; all materials, such as nails, screws, canvas, glue, etc., and sundry materials paid for out of the petty cash which cannot be booked directly to the jobs.

(4) The establishment charges, which include the monthly salaries or drawings of partners or proprietor, office salaries, rent, rates and taxes, advertising and exhibition expenses, interest on capital, insurances, legal expenses, cash discounts, profit and loss items, such as bad debts, depreciation items, lighting, repairs to premises, patent and registered fees, postage and stationary, and all other general expenses.

A Simple System means Fewer Mistakes.—For the purpose of recording cost, some firms adopt a card system throughout their costing department, but this is not altogether satisfactory for motor-coach builders, on account of the complication of trades and the bulkiness of the work entailed. Frequently the jobs hang about some time, and there is some risk of a card getting lost unless there is an elaborate system of filing, and if a deal of money has to be spent unnecessarily in working a card system, it is better to be without it, as an object in costing is to reduce and not to increase expenditure. The purpose of this chapter is to outline a system which could be adopted by either small or large firms, so a complete card system is ignored. The simpler the system the less likelihood will there be of mistakes occurring. At the same time, however, it should be made as perfect as possible, and there should be no stinginess in providing what is necessary to carry the system through properly. Everything depends upon the accurate entering of all details, and the storekeeper and clerks must be smart and reliable men, and, if possible, they should have some technical knowledge of the trade. The costing must be worked up day by day as regards materials, and weekly or monthly as regards labour. Nothing should be allowed to accumulate, or the work will get out of hand and something will be missed.

Books Required.—The following list of books will be required, and their uses will be explained later :—

(1) The Orders Inward Book, to enter up all orders received for new work.

(2) A small set of books for entering up the daily labour of the day men.

(3) A set of departmental labour books, into which will be written up once a month the labour on each job.

(4) The New Work Cost Book, suitably ruled, into which will be posted all the items which make up the cost.

(5) A Repairs Cost Book, to enter up the cost of repairs in the same way.

(6) A Stores Stock Ledger, for entering up all stores received and given out.

(7) An Accessory Cost Book, similar to the Repairs Cost Book, for enter-

ing up the cost of new wheels, wind-screens, and such things made for stock. These books should be properly designed for their respective purposes, and wherever possible they should be printed.

The Orders Inward Book.—An order for a motor body having been obtained, or a decision come to to build for stock, a principal or the works manager should settle all details and see that they are correctly entered in the Orders Inward Book. Much time will be saved if all particulars are carefully gone into at the commencement and noted down, as there will then be no need for inquiries to be made or correspondence to be referred to. The Orders Inward Book should be provided with an alphabetical index, ruled in four columns, the first for the customer's name, the second for the works reference number, third for the description of body, and the fourth for the number of the page. At the top of each page of the book would be spaces for the customer's name and address, the date the order is commenced, the works number, and the reference number of the specification. With regard to the works reference number, this is the number allotted to the vehicle when it is commenced, and it should be known by it right through the works. Different firms have different ways of doing this, but whatever method is adopted the number should be stamped on some prominent part of the body, so that it can be seen by everybody.

The Order Card.—Having settled all details, the works manager will instruct the draughtsman, where there is one employed, as to the full working draft. An order card, which would be practically a replica of a page of the order book, would then be prepared and handed to the bodymaker. This card should be attached to the body and go right through the factory with it. Any extras decided upon during the course of construction should be noted on it, as well as entered in the order book. Fuller particulars would be set out on the card than are given in the order book, such as the kind and strength of plates to be used and the quality of materials. Nothing should be left to the workman, but on all points the works manager should be consulted. He knows what the estimated cost is, and should see that nothing exceeds it.

Requisition Sheets.—A set of cards or sheets should be designed for the requisition of goods from the stores, and not a scrap of material should be given out unless the particulars are fully entered upon it. They can be printed in large quantities, and need not be an expensive item. They should be kept a reasonable time for reference, and in order that they may be more easily referred to, each department might have a different colour. If sheets are used, they should be punched in the corner and strung together, so that there may be no excuse for wasting them.

A. STORES REQUISITION SHEETS.

[1] BODYMAKERS' DEPT.

No. .....

Name or Works Reference No. .....
Signature of User .....

Date.	Quantity.	Description.	Rate.	Amount.

Entered in Stock Ledger by .....

Entered in..... Cost Book, page ..... by .....

(This sheet is not to be used for Timber.)

Everything possible is to be had out at one time, and on no account will goods be served unless a sheet is handed in. Full particulars of requirements must be given and the sheet properly made out, or it will be rejected. Where goods are for general use, the words "General Use" should be inserted in place of Works No.

B. STORES REQUISITION SHEETS.

TIMBER ONLY.

No. .....

Name or Works Reference No. .....
Signature of User .....

Date.	No.	Use.	Kind.	Thickness.	Length.	Width.	Super.	Rate.	Amount.

Served by .....

Entered in Stores Stock Ledger by .....

Entered in ..... Cost Book by ..... page .....

[1] Similar sheets may be used by all departments except for timber and iron, but each department should have a different colour.

C. STORES REQUISITION SHEETS.

IRON ONLY. No. .....

Name or Works Reference No. .....
Signature of User .....

Date.	No.	Use.	Section.	Size.	Weight.	Rate.	Amount.

Entered in Stores Stock Ledger by .....

Entered in ..... Cost Book, page ..... by .....

Piece and Day Workers' Books.—The labour employed may be either piece or day work, or both. In either case the method employed to ensure that all work is duly charged up should be as simple as possible. If it is piecework, the piecemaster should be provided with a book in which he makes up his charges. If day work, the workman should have one of the small books mentioned, into which he will enter each day the number or name of the job, the details of work done to it, and the time spent on it. Day workers' books should come into the office each day and pieceworkers' at the end of each month. In both cases they should be immediately checked as to the time in one and the prices in the other, and any queries raised should be gone into and settled right away. Much time and friction will be saved if this is done at once, as a proper explanation can often be given at the time; but if a period is allowed to elapse before the man is called to book, an excuse may be invented, and the result is unsatisfactory to both sides. The day men's work should be priced and reckoned out at the price per hour, and, where possible, the work should be written up in the departmental labour books. That is to say, as each job is finished, the total amount of work should be written off, together with the time and the cash amount. If a practice is made of doing this as each job is finished, it relieves the clerk of a deal of work at the end of each month, when there are certain to be a lot of other items requiring attention; but if a job is unfinished at the end of the month, the labour and amount should be written up and posted at that date. The hours worked and the cash can then be totalled up and agreed with the time and wages book. In some factories it is the custom to price the day men's work according to the piecework rate where possible; but as we have to get down to actual prime-cost, this is not advisable. At the same time, however, a sharp look-out should be kept that the work is not costing more than it would if piecework were employed.

After the work has been written up in the departmental labour books, the amount of each job, together with the folio and workman's name, should

be posted in the labour columns of either the new work or repairs cost books, and special care should be taken in doing this, as anything posted in the wrong place might not be found out, and the whole system would be useless.

New Work and Repairs Cost Books.—The new work and repairs cost books should be ruled in such a way that everything is very clearly shown, and as little chance as possible given for mistakes to be made. That is to say, the columns in it should be very complete, so that omissions may be seen almost at a glance when the costs are totalled up. The works reference number should be at the top of the page with the description of vehicle, or in the case of the repairs cost book, the name of the customer would occupy this space. Labour should be in the first column, and materials should be divided into sections, i.e. a column should be provided for each department and also one for goods bought specially for and booked direct to the job. To save time each column might have a few of the principal things printed in. This of course refers to the new work book ; the repairs book need not be so elaborate, and need have two columns only, one for labour, the other for materials. Both books should be provided with an index. Each job should be totalled up directly all the items are booked, and the proportion of working and establishment charges added. The same rules will apply to the accessories stock cost book, and store numbers should be given to each and the cost kept just as carefully as it would be in the case of vehicles. When anything is used the cost, either as a total or in detail, would be transferred to the other cost books.

Invoices.—A note to the effect that the invoice must be sent with all goods, or immediately afterwards, should be printed on the order forms, and the storekeeper should see that the rule is rigidly adhered to, and any departure from it followed up by a reprimand *at once*. It should also apply to work done outside, such as lamp-making, beading, joinery, etc.

By this means the goods can be immediately checked by the invoices and put away or given out for the job for which they are intended. The invoices should bear the order number, and should be compared with the order to see that the correct quantities are delivered. When passed, they should be handed to a qualified person to check as to the charges, and then on to a clerk for the extensions and castings to be checked. Each of these persons should initial the invoice. This brings us to the—

Stores Stock Ledger.—The object of this book is to keep a perpetual account of goods coming into and going out of the storeroom day by day, in order that the stock in hand may be ascertained at any time.

The best way to do this is to have the pages ruled similar to an ordinary ledger. The debit side would be for goods received, the credit side for goods given out.

The former would be entered up from the invoices, the latter from the stores requisition sheets. The idea is to open an account in the ledger for every kind of article used. As it would be rather a bulky volume, it would

perhaps be better to have separate ledgers for, say, timber, iron, colours, brass, and other goods, and trimming materials. At first sight it may appear that it would be better to group several articles together under one account, but as entries have to be made from the invoices and requisition sheets for every kind of article, it will not be very much more trouble to have separate accounts for everything.

There will be a little more turning up of accounts to be done, but it will be repaid by its lucidity. Properly kept, this book should do away with counting the stock at stocktaking periods. If it is a fresh innovation, the stock would have to be carefully and accurately taken at a given time, and the exact quantities on hand, together with prices, written up. Taking first of all timber, we should have separate accounts for English ash, American ash, mahogany, spruce, whitewood, birch, and so on. The timber should have accounts for each thickness. In the iron accounts we should have a page for each different size of general iron, hooping, angle iron, bolts and nuts, etc. Painting goods would have separate heads for each kind of varnish, Japan gold-size, whitelead, turpentine, linseed oil, ground colours, dry colours, brushes and tools, leathers, sponges, etc.

Trimmers' goods would have separate accounts for the different kinds of leathers, cloths, carpets, canvases, linens, silks, cords, cushion springs, rubber, laces, reps, floorcloths, and so on. Brass and plated goods would have accounts for locks, angle plate, door handles, brass plate, hinges, etc. The different accounts which would be required are much too numerous to mention, but those enumerated will serve to show what is meant. There is scarcely any need to emphasize the necessity of keeping these books entered up daily, while frequent balances (as often as once a week would be advisable) should be struck, so that it does not get out of hand and become simply a chaos of figures which would take a considerable time to reduce to a useful state if the storekeeper were called upon suddenly to give an account of the goods he has on hand. The drawback to grouping articles together in these books would be that, to ascertain how, say, a certain parcel of $1\frac{1}{2}$ in. ash, or a piece of cloth has been used, it would be necessary to analyse the whole of the group, while every group would have to be analysed at stocktaking. It is, therefore, apparent that separate accounts for everything will be of much greater utility and simpler in the long run, although it cannot be denied that it will make rather more work. At stocktaking, it should be the practice to take a few items at random and check the goods against the book.

Serving out the Stores.—The serving of goods from the stores should be by means of the stores requisition sheets already mentioned. When the job comes into a department, the responsible man should make out a list of his wants, and, as far as possible, get everything from the stores at one time. He must see that every item is correctly entered, and sign the sheet in the space provided. To prevent time being wasted by a number

of men or apprentices congregating at the stores at one time, it should be the rule for the sheets to be presented at the stores in the morning—say, within half-an-hour of opening time—and left there. The storekeeper will then deal with each one in rotation, and get the goods ready to be called for, say, an hour later. It is true this will mean two journeys, but it is better than making a special time for serving and allowing the men to wait while others are being served. They may not be kept very long, but if several are waiting while one is getting a long list of goods out, an hour or so is soon wasted. Say an average of five men are kept waiting at the stores a quarter of an hour each morning, and reckoning the working days in the year as 300, there will be 375 hours wasted annually. Putting the value of this at not more than 6*d.* per hour, the sum of £9 7*s.* 6*d.* will have been wasted, but it will be readily seen that in a fair size factory the sum will be much larger. In dealing with the sheets the storekeeper would tick off each item as he serves it, and where there is more than one quality or kind in stock add the cost price in the column provided. Anything not in stock should be entered in a small book, and this should be handed to the buyer each day in time for the orders to catch the country posts. At the same time, a smart works manager will have known previously if anything is wanted which is not usually stocked, and will have seen that it is ordered at the earliest possible moment, so that there may be no delay when it is required.

After the goods have been served, the costs should be worked out and each item credited to its account in the stores stock ledgers. Having initialled the sheets, the storekeeper will now hand it on to the costing clerk, who will check the figures and enter the goods and the amount in the columns of the cost books. This may be done by entering only the total amount of each sheet, but by far the better plan will be to have as full detail as possible. This will be better for reference, and at the same time omissions will be more easily detected, or cases of goods having been had out twice for the same job can be at once looked into.

The Special Difficulties of Timber, Iron, and Paint.—Timber and iron cannot, of course, be kept in the storeroom, so special requisition sheets should be provided for them. The timber can be placed in charge of a timber marker, who should be held responsible for seeing that the correct measurements are given and that no timber is supplied without a sheet. The same remarks as to the sheets being handed to him first thing in the morning apply as in the case of the stores. In calculating the quantity of timber, waste must be reckoned in, and the result given in super measurements. The sheets should be handed to the storekeeper for the quantities to be worked up and priced and entered in the stores stock ledger, and so on to be entered in the cost books. Unless the iron stock is under the direct charge of the storekeeper it will have to be dealt with in much the same way, the foreman smith being held responsible for handing in to the

storekeeper each day sheets giving the weight and kind of iron used during the day. The men should be impressed with the importance of accurately charging up every piece of iron to the respective jobs, and the sheets should be entered in the same way as the others. The paint stock will also present a little difficulty, as it is hardly possible to dole out just sufficient colour or turpentine for each job, in fact, it would not pay to do so, but requisition sheets must certainly be used, and the material weighed or measured out. The sheets for japan, varnish and gold-size, or expensive colours should bear the name or works number, and be booked in the same manner as other stores. With regard to the rest of the colours and materials of all kinds as well as brushes used by the painters, it would probably be a good plan to total for twelve months the amount of wages paid in this department, and reckon out the value of the material used in the same time, and work out the percentage of one to the other. To check this it would be as well to take the average for, say, three years. The percentage would be booked to each job in the cost book—in the column where the painter's work is booked. With regard to the materials or work done outside specially, it has already been mentioned that the charges should be sent in at once, and these charges should be posted direct into the cost books in the columns to which they refer, or a special column may be provided. The storekeeper must be careful to see that material specially obtained is not also charged through the stores requisition sheets, but in case anything does get overlooked by him the columns in the cost book should reveal the error.

Materials for General Use.—We have now disposed of the labour and materials which can be booked direct to the costing accounts, and have now to deal with the shop expenses and working charges, including the materials which cannot be booked direct. As regards the latter, colours can be left out, as we have already dealt with them. Other materials consist of screws, nails, glue, string, flax, glasspaper, files, tow, tyre cement, and the very large number of similar things used in motor-body construction. No departure should be made from the rule of obtaining them by the use of the requisition sheets, mainly because they will have to be credited in the stock ledger, and also because the mere fact of their having to be applied for in a formal way, with the knowledge that they are booked against the user, will tend to economy. There will also be the sundry materials paid for out of petty cash, and these should be booked in a special column in the petty cash book, so that they can be easily dissected. Labour which cannot be booked direct should be obtained from the wages book, the analysis of which should each month separate the wages paid to foremen, timber markers, machine men, storekeepers, labourers, and others whose time is not charged up. Special accounts should be kept by the accounting departments of the office for such item as machinery and upkeep and repairs to same, cost of power for running, cost of tools and repairs, plant and firing for smithy, cost of repairs to premises, or labouring by men whose time is

booked direct, but cannot be charged to any special job, such as lifting or going out to take particulars for estimating. To get all these items together it might be useful to employ a book, under the title of shop and general expenses book, into which these could all be posted up each month. A summary would be made from the stores stock ledger of the materials. sundry items would be posted from the petty cash book, indirect wages from the wages book, machinery, firing, etc., etc., from the analysis of the invoice book, and all items done by the mechanics, from the departmental labour books. These items would be totalled up each month, and a grand total made each year and added to the establishment charges.

Establishment Charges.—The last item (but by no means the least) is the establishment charges. Many of these are private, and it is not, of course, necessary for the costing staff to know each item, but they should be carefully worked up from the accounts, and the percentage figure added to each cost account. Some of the items would be obtained by the monthly analysis of the invoices and others from the private cash book ; they should all be properly journalized and taken into the ledgers to their separate accounts, so that a yearly abstract can be easily made.

These charges should be carefully made up, as a great deal will depend upon the proper figure being obtained as to whether the rate of profit at which the firm has been supposed to be working is real or fictitious. There is not sufficient margin in present-day profits for guessing or " adding a bit," and the care spent on arriving at the actual figure will be amply repaid. There is likely to be fluctuation in the expenses from year to year from reasons which are apparent, so no time should be lost in getting out the figures at the end of the financial year, and, if necessary, the rate should be amended at once. In estimating for large quantities of work, it is essential to base the rate on the assumption that the works are in full swing as they would be if the order were obtained, as they will be sure to jump up directly, especially if it is after a season of slackness when it has been the rule to cut down expenses in every possible way. The basis of calculation of these charges should be that the percentage is worked out on the probable selling value. Having obtained all the figures for the year which come under the heading of expenses, the total of the sales for the same period should be taken, and the ratio worked out by the rule of three, the sales being the first term, the expenses the second, and the third 100, the result being the amount per cent. to be added to each cost account in the cost books. Having ascertained the ratio of expenses to sales, it is evident that the amount to be added should not be on the cost, but on the selling value. The stocktaking figures at the commencement and end of the year will, of course, have to be taken into the account. By adding this percentage to the costs already obtained and entered up in the cost book the actual prime-cost of the motor-body or job is obtained, and the difference between this and the selling price is the actual net profit. If a system of prime-costing is rigidly adhered

to, nothing will be missed in booking, and the manufacturer will see exactly what profit each transaction bears, and will not be working in the dark if it becomes necessary at any time to reduce his selling price.

Criticism of the Essay.—This essay treats the subject with a refreshing clearness, and each step in collecting the various items which go to make up the prime-cost is fully described. The author, in his introductory remarks, warns us that he is no lover of elaborate card systems, and in perusing the system which he proposes I find that simplicity is studied, but not to a degree which would be detrimental in arriving at an accurate cost.

We are advised to rule our orders inward book with a four column index with columns for the customer's name, works number, type of vehicle, and folio number, and although I think the type of vehicle column might be left blank when orders do not continually flow from the same client, yet a works number index would also be useful as well as this book, so that a job can easily be found from its number. I also notice that the system of providing each day worker with a book to book up his time is adhered to, but I should suggest that ordinary time sheets are simpler where the workman is only asked to book the number and time spent on each job, especially as it is suggested they go into the office each day, and I think the departmental labour books might be dispensed with, as the information so collected could be posted direct into cost books. I also notice he advocates the stores stock ledger and says that if properly kept it should do away with counting the stock at certain periods, and where any firm has faith in the records of this book it certainly ought to, but why is stock still counted in so many shops, where the systems in vogue are supposed to do away with it ?

I am glad to note that frequent balances are advocated, and I quite agree that each article and each variety of that article should have a separate heading, however bulky a volume or set of volumes it may entail. A storekeeper or clerk can book them up from the requisition sheets easily if he has a large desk, and he soon gets to know many of the folio numbers by heart. A point not insisted on here is that the booking up of the store ledger should be done in the stores, where any query can immediately be dealt with. Many errors creep in where the booking is done by a more or less non-technical clerk away from the stores, who does not always trouble to ask when he is not sure of the wording on a requisition sheet. There are many hints of great practical value in this essay, and it bristles with trite sayings from which one may conclude that the author is a man who is used to keeping a continual eye on waste. The difficulties of timber, iron, and paint shop material are described, and I note that in the latter department the plan of totalling up for twelve months the amount of wages paid in the department is advocated, and reckoning out the value of the material used, and charging it up according to the relationship of these two totals. It is in these three departments that the weakness of a motor-body builder's prime-costing lies, and on the success of this portion of the

work depends in a great measure the accuracy of the final totals arrived at. Another difficulty is the odds and ends which cannot be booked to any job direct, and the labour which is expended over several jobs, such as the duties of foremen, machinists, etc., but it is clearly shown how to deal with them.

I would like to mention at this period an extract from a letter of a member of The Institute of British Carriage Manufacturers, who is a well-known general manager of a London firm, to his fellow colleagues, which deals aptly with percentage of establishment charges :—

As far as I can gather, all fair-sized coachbuilding factories, and many of the small ones have a system of collating the cost of labour and material expended upon a job, but where these systems very often fail is in the apportioning of the establishment charges. Instead of actually working out the establishment charges it seems to be the custom to work by rule of thumb, and "add a bit." It may be a certain percentage either based on labour or material, or both, but it has never been worked out properly in the first instance, and it is not until the auditors come in at the end of the financial year that it is known whether a profit or a loss is being made. The working out of the establishment charges is not so appalling as the majority of people seem to think. Personally, I am in favour of basing the proportion of establishment charges to the productive labour on the job, as in the coachbuilding trade it is the most constant factor. A formula I compiled many years ago seems to suit this particular trade very well, and can be adapted to most manufacturing trades. I have used it in connexion with businesses so widely differentiated as coachbuilding, engineering, dentistry, and dressmaking. This formula reads as follows :—

$$\text{E.C.} = \frac{\text{T.E.} - (\text{P.L.} + \text{P.M.}) \times 100.}{\text{P.L.}}$$

Where
E.C. = Establishment Charges.
T.E. = Total Expenditure, i.e. the whole of the payments made throughout the whole year, no matter for what purpose.
P.L. = Productive Labour, i.e. labour which actually contributes to building the body or executing the repair.
P.M. = Productive Material, i.e. material actually existing in the finished article.

Example :—

$$\text{E.C.} = \frac{30{,}000 - (12{,}000 + 10{,}800) \times 100.}{12{,}000.}$$

$$\frac{30{,}000 - 22{,}000 \times 100}{12{,}000} = \frac{720 \times 1 = 60}{12} = 60\ \%.$$

The algebraical form of the above formula need not worry the man whose algebra has gone rusty, as put into plain English, if one adds the productive

labour to the productive material, and subtracts this from the total expenditure, one gets the exact amount of the unproductive expenditure. Then, to get at the percentage in proportion to the productive labour, one need only multiply the unproductive expenditure by 100, and divide by the amount of productive labour. The result will be the percentage of establishment charge to be added to each job in proportion to the amount paid in wages on the particular job.

ESSAY No. II.[1]

It is not the writer's intention to prepare an essay on this important subject, which would be full of intricate problems, but simply to place before you on the following pages an easy and accurate method of arriving at the prime-cost of a motor body with as little clerical labour as possible. In the first place, I want to carry through from the very beginning to the end a complete body. An order having been received for a certain class of body, you find that a specification, call it No. 16, includes all the details. You then get your order book ruled (see D) and the full particulars are entered therein

D. COPY OF OFFICE ORDER BOOK.

FACTORY ORDER No. 1.

Time tabs issued to coachbuilding department, 2/4/12.
„ „ painting „ „
„ „ trimming „ „
„ „ smithing „ „
Requisition issued to stores „ „

Customer's Name	WILLIAM WHITE, Esq.
Address	Earnock House, Hamilton
Description of body	No. 16 Specification
Body painted	„ „
Body lined	„ „
Upholstered	„ „
Extra instructions	

Delivery wanted 10/5/12. Despatched 8/5/12.
Per Caly. Ry. Carriage paid.

[1] By Mr. James R. Black.

as follows: (1) Factory Order No. (2) date tabs issued to bodymaker's, painting, trimming, smithy departments; (3) date of requisition issued to stores department; (4) customer's name and address; (5) description of body; (6, 7, 8) body painted and lined, upholstered; (9) any extra or special instructions; (10) delivery wanted, body number, despatched, per railway company, carriage forward or paid. This office order book is to be written up by the clerk in the office. I have filled in full particulars of first order received, and you will notice that, instead of stating the full particulars, I have given a specification number. Should you not have a specification, then a drawing-number is quite sufficient, provided each department has been provided with a copy of the particulars. After the order book has been carefully entered up by the clerk, the next thing he does is to write out a stores material requisition sheet for each department with the necessary stores; at the same time the individual receiving the stores must initial the sheet and see before initialling what he signs for. When these material sheets are completed, the storekeeper passes them to each of the foremen representing the various departments, who carefully check all the stores issued, and if in order sign same and then pass back to storekeeper. The storekeeper initials the sheet after receiving same from foremen, and sends it to the clerk in office.

In order that no misunderstanding may arise, I have filled up the bodymakers' sheet (see E), given full details of all the materials issued to the workers for body No. 500; of course, so far as the timber is concerned, I have put the measurements into square feet, the other items, I think, should be quite clear. All the other material sheets are made out in a like manner, and they have been sketched out roughly, which will enable you to follow me closely. I would advise that you get these sheets printed. The cost would be very little, and also I would be inclined to give each department a different colour. The standard size of your material sheets should be not less than 13 in. by 8 in., common foolscap size.

BODY No. 500.

E. STORES ISSUED TO BODYMAKERS' DEPARTMENT.

For Body No. 500. Factory Order No. 1.

(Colour of this to be white.)

Type of body	. . .	Side entrance, per specification No. 16.			
Marker off	. . .	Check No. 982.	Name,	W.	Bell.
Sawyer	. . .	,, ,, 983	,,	P.	Smith.
Bodymaker	. . .	,, ,, 984	,,	J.	Lamb.
,,	. . .	,, ,, 985.	,,	J.	Scott.
Finisher	. . .	,, ,, 986	,,	J.	Lee.

Material.	Quan.	Rate.	£ s. d.	Date.	Rec'd by.	Remarks.
Ash	40 ft.	5*d.*	0 16 8	2/4/12	W.B.	
Birch	50 ft.	5*d.*	1 0 10	,,	P. S.	
Pale mahogany	4 ft.	9*d.*	0 3 0	,,	,,	
Top door hinges	2	8*d.*	0 1 4	6/4/12	Q. S.	
Outrigger hinges	2	9*s.* pair	0 9 0	,,	,,	
$\frac{7}{8}$ in. brass door plate	6	4*s.* 6*d.* per doz.	0 2 3	,,	,,	
Slam lock	2	2*s.* 3*d.* each	0 4 6	,,	,,	
Hinges for inspection board	2	4*d.* pair	0 0 4	7/4/12	,,	
Hinges for heel board	2	,,	0 0 4	,,	,,	
Spring catch for heel board	2	1*s.* 6*d.* each	0 3 0	,,	,,	
Front steel wings	2	3*s.* each	0 6 0	,,	,,	
Rear ,, ,,	2	2*s.* 9*d.* each	0 5 6	,,	,,	
Aluminium moulding	20 ft.	6*d.* per ft.	0 10 0	,,	,,	
Screws (assorted)	3 gr.	1*s.* 2*d.*	0 3 6	,,	,,	
Door handles	2	2*s.* each	0 4 0	,,	J. L.	
Capped inside nuts	2	8*d.* each	0 1 4	,,	,,	
Extras						
			4 10 1			

(*Signed*) J. White, *Foreman.*
J. Bolton, *Storekeeper.*

F. STORES ISSUED TO PAINTING DEPARTMENT.

For Body No. 500. Factory Order No. 1.

(Colour to be red.)

Type of body . . Side entrance, per specification No. 16.
Filled up . . . Check No. 987. Name, J. Bruce.
Rubber down . . . ,, ,, 988. ,, J. Burke.
,, ,, . . . ,, ,, 989. ,, J. Wallace.
Painter . . . ,, ,, 990. ,, W. Bennett.

Material.	Quan.	Rate.	£ s. d.	Date.	Rec'd by.	Remarks.
White lead	4 lb.	22*s.* cwt.	0 0 10	20/4/12	W. B.	
Filling up	18 lb.	23*s.* cwt.	0 3 8	9/4/12	J. B.	
Colour (green)	2 lb.	5*d.* lb.	0 0 10	20/4/12	W. B.	
Black Japan	2 gills	16*s.* gall.	0 1 0	,,	,,	
Gold-size	1 gill	9*s.* ,,	0 0 4	,,	,,	
Turpentine	$\frac{1}{2}$ gall.	4*s.* ,,	0 2 0	,,	,,	
Linseed oil	4 gills	2*s.* 6*d.* gall.	0 0 4	,,	,,	
Ground pumice	$\frac{1}{2}$ lb.	9*s.* cwt.	0 0 1	13/4/12	J. W.	
Pumice bricks	4	4*s.* doz.	0 1 4	,,	,,	
Hard drying body varnish	4 gills	26*s.* gall.	0 6 6	22/4/12	W. B.	
Durable ,, ,, ,,	2 ,,	24*s.* ,,	0 3 0	23/4/12	,,	
			0 19 11			

(*Signed*) J. Murphy, *Foreman.*
J. Bolton, *Storekeeper.*

G. STORES ISSUED TO TRIMMING DEPARTMENT.

FOR BODY NO. 500. FACTORY ORDER NO. 1.

(Colour of this to be blue.)

Type of body . . Side entrance, per specification No. 16.
Trimmer . . . . Check No. 991. Name, W. SMITH.
„ . . . . „ „ 992. „ J. PETERS.
Machinist. . . . „ „ 1,000. „ NELLY SMITH.

Materials.	Quan.	Rate.	£	s.	d.	Date.	Rec'd by.	Remarks.
Buffalo hides	3	50*s.* each	7	10	0	29/4/13	W. S.	
Best horsehair	26 lb.	2*s.* 1*d.* lb.	2	14	2	„	„	
D.D. canvas	8 yds.	1*s.* 6*d.*	0	12	0	„	„	
Scrim	4 „	6*d.*	0	2	0	„	„	
Tacks	3 pkts	2*d.*	0	0	6	„	„	
Solution	3 lb.	1*s.* 5*d.* lb.	0	4	3	30/4/13	J. P	
Twine	1 ball	3*d.*	0	0	3	„	„	
Reel thread	1	2	0	0	2	„	„	
1 rear spring frame .) 2 front „ „ .)	1 set	—	0	10	6	„	„	
Studs	1 gr.		0	1	0	„	W. S.	
Felt	6 yds.	1*s.* 6*d.* yd.	0	9	0	„	„	
Springs	34	6*s.* gr.	0	1	5	„	„	
⅜ in. Beading brass . .	24 ft.	2*s.* 12 ft.	0	4	0	„	„	
¼ in. rough brass . . .	6 ft.	1*s.* 8*d.* 12 ft.	0	0	10	„	J. P.	
Brass press buttons . .	6	8*s.* gr.	0	0	4	„	„	
Linoleum	6 yds.	1*s.* 6*d.* yd.	0	9	0	„	„	
Extras								
			12	19	5			

(*Signed*) R. MCNEE, *Foreman.*
J. BOLTON, *Storekeeper.*

H. STORES ISSUED TO SMITHY DEPARTMENT.

FOR BODY NO. 500. FACTORY ORDER NO. 1.

(Colour of this to be yellow.)

Type of body . . Side entrance, per specification No. 16.
Blacksmiths . . . Check No. 1,001. Name, J. MACNEIL.
„ . . . . „ „ 1,002. „ J. SMITH.

Material.	Quan.	Rate.	£	s.	d.	Date.	Rec'd by.	Remarks.
2 seat valances . . .	5 lb.	9*s.* cwt.	0	0	5	3/4/12	J.McN	
Corner plates, ⅞ in. R.M.S.	6 „	9*s.* „	0	1	0	„	J. S.	
Hind pillar plates (2) .	14 „	9*s.* „	0	1	2	„	„	
Back centre plate (1) .	20 „	9*s.* „	0	1	7	„	„	
			0	4	2			

(*Signed*) J. RUSSELL, *Foreman.*
J. BOLTON, *Storekeeper.*

I. BODYMAKERS' DEPARTMENT—WORKERS' TIME TAB.

(Colour of this to be white. Size 6½ in. × 8 in.)

FACTORY ORDER No. 1. BODY No. 500. DATE ISSUED, 2/4/12.

Style of body: Side entrance. Specification No. 16.

Operation.	Check No.	Name.	Week ending.	M.	T.	W.	Th.	F.	S.	Total hours.	Rate per hour.	£	s.	d.
Marking off wood	982	W. Bell	4/4/12	2						2	9*d.*	0	1	6
Machining wood .	983	R. Smith	,,	7	9¾	1¼				18	6*d.*	0	9	0
Coachbuilding .	984	J. Lamb	,,			8½	9¾	9¾	4¾	32¾				
,, .	985	J. Scott	,,			8½	9¾	9¾	9¾	32¾				
,, .	984	J. Lamb	11/4/12	9¾	9¾	7¼				26¾				
,, .	985	J. Scott	,,	9¾	9¾	7¼				26¾	8½*d.*	4	4	3
										119				
Finishing . . .	986	J. Lee	8/5/12					4		4	8*d.*	0	2	8
												4	17	5

(*Signed*) J. WHITE, *Foreman.*

The foreman to examine very minutely all time tabs, and if in order to sign same and return to office for costing purposes.

The next time tab I want to deal with is the painting department, which is shown with all time entered up, so that you should have no difficulty in following the method submitted. Great care should always be exercised in seeing that the worker records his proper time against each body, and a smart foreman should have no difficulty in detecting anything wrong.

J. PAINTING DEPARTMENT—WORKERS' TIME TAB.

(Colour of this to be red.)

FACTORY ORDER No. 1. BODY No. 500. DATE ISSUED, 2/4/12.

Style of body: Side entrance. Specification No. 16.

Operation.	Check No.	Name.	Week ending.	M.	T.	W.	Th.	F.	S.	Total hours.	Rate per hour.	£	s.	d.
Filling up . . .	987	J. Bruce	11/4/12				5¾	¼		6	6*d.*	0	3	0
Rubbing down .	988	P. Burke	18/4/12	5	4	3				12	6*d.*	0	6	0
,, ,, .	989	J. Wallace .	,,	5	4	3				12	6*d.*	0	6	0
Painting . . .	990	W. Bennett .	25/4/12	9¾	9¾		6½			26				
,, . . .	990	,,	2/5/12	9	9		2			20				
										46	8*d.*	1	10	8
												2	5	8

(*Signed*) T. MURPHY, *Foreman.*

K. TRIMMER DEPARTMENT—WORKERS' TIME TAB

(Colour of this to be blue.)

FACTORY ORDER No. 1. BODY No. 500. DATE ISSUED, 2/4/12.

Style of body : Side entrance. Specification No. 16.

Operation.	Check No.	Name.	Week ending.	M.	T.	W.	Th.	F.	S.	Total hours	Rate per hour.	£	s.	d.
Trimming . .	991	W.Smith	2/5/12				7	$9\frac{3}{4}$	$4\frac{3}{4}$	$21\frac{1}{2}$				
,, . .	992	J.Peters	,,				7	$9\frac{3}{4}$	$4\frac{3}{4}$	$21\frac{1}{2}$				
,, . .	991	W.Smith	9/5/12	$9\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{3}{4}$			39				
,, . .	992	J. Peters	,,	$9\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{3}{4}$			39				
										121	8*d.*	4	0	8
Machining. . .	1000	Nelly Smith	,,	9	3					12	3*d.*	0	3	0
												4	3	8

(*Signed*) R. MCNEE, *Foreman.*

L. SMITHY DEPARTMENT—WORKERS' TIME TAB.

(Colour of this to be yellow.)

FACTORY ORDER No. 1. BODY No. 500. DATE ISSUED, 2/4/12.

Style of body : Side entrance. Specification No. 16.

Operation.	Check No	Name.	Week ending.	M.	T.	W.	Th.	F.	S.	Total hours.	Rate per hour.	£	s.	d.
Seat valances (2)	1,001	J.McNeil	4/4/12	1						1	1*s.*1*d.*	0	1	1
Corner plates (2)	1,002	J. Smith	,,		1					1	,,	0	1	1
Hind pillar plates (2)	,,	,,	,,		1					1	,,	0	1	1
Back centre plate (1)	,,	,,	,,		1					1	,,	0	1	1
												0	4	4

(*Signed*) J. RUSSELL, *Foreman.*

The office have now received all the information to arrive at the prime cost of body No. 500, and I give a sketch of a master's cost and comparison tab, and from the material sheets, after I have priced and extended same, I enter against each department total amount of material used, afterwards entering up against each department total amount of wages paid on body No. 500, and, by adding material and labour, you have your first or prime cost; a column is left for your oncost, total, and selling price. Should you

M.

MASTER'S PRIME COST OR COMPARISON TAB.

(Size 6½ in. × 8 in.)

FACTORY ORDER No. 1. BODY No. 500.

Style of body : Side entrance. Specification No. 16.

Customer's Name and Address.	Date.	Department.	Net material.	Net labour.	Prime cost.	50⅓ per cent. on cost on labour.	Total.	Invoiced at
			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	
		Bodymaking . .	4 10 1	4 17 5	9 7 6	2 9 0	11 16 6	
W. White,		Painting . . .	0 19 11	2 5 8	3 5 7	1 3 1	4 8 8	
Earnock House,	1912.	Trimming . .	12 9 5	4 3 8	17 3 1	2 2 2	19 5 3	
Hamilton.	May 8.	Smithy . . .	0 4 2	0 4 4	0 8 6	0 2 2	0 10 8	
			18 13 7	11 11 1	30 4 8	5 16 5	36 1 1	

Work done outside .....

have a number of orders for, say, specification No. 16, every one should be entered on this tab, so that you could see from time to time whether the cost was going up or down, and also, if you wanted to fix piecework rates, you could have the necessary data from this tab to work upon.

The above tab to be made of cardboard and ruled on both sides, and these to be classified according to design of body and kept in a box. When the clerk in the office has entered up all the body material sheets, and sent them to stores, he afterwards makes out a worker's time tab for each of the various departments, and sends same to the foreman, who enters worker's check number and name on same. The time cards to correspond in colour to material sheets, but instead of common foolscap paper as with the material sheets, it is better that they should be made from cardboard, as, being handled daily, they require to stand tear and wear. The size of tab not to exceed $6\frac{1}{2}$ in. by 8 in., and to be printed, the cost is very little. I have filled up all the workers' time tabs for bodymaking, painting, trimming, and smithy, and with a little care you will no doubt be able to follow me closely. The tab, as you will see, passes from operation to operation, and it is advisable that these tabs should be entered up daily, and at the end of the week they should be collected and checked by wages clerk in order to see that each worker has put in his time as per time book. What I mean by this is, sometimes I have come across worker's time in works, say, 48 hours for the week, and when their time tab was examined, they put down 52 hours. Time tabs must be thoroughly checked, otherwise the cost is valueless. I refrain from going into the various methods of timekeeping, as there are so many. However, from the sketches which appear on the preceding and following pages I have no doubt that everything will appear plain and simple.

I have now come to the end of my task so far as the prime-cost is concerned, but in order to keep everything as simple as possible, I now show all the cards and sheets used in arriving at the prime cost :—

Book and material sheets and time tabs used in making up the prime cost of a motor-body consist of office order book, stores issued to bodymaking, painting, trimming, smithy, master's prime cost or comparison tab, bodymaker's time tabs, also the painter's, trimmer's and smithy time tabs.

Summary in Details.—(1) Clerk in office to enter up office order book.

(2) Clerk in office to fill up stores material requisition sheets and send to storekeeper.

(3) Clerk in office to fill up time tabs for each department and send to foreman.

(4) Storekeeper to fill up stores received by workers on stores material sheets, and when completed to send same to foreman for checking purposes and to have it initialled by foreman and himself and send sheets to clerk in office.

N.

Stock Card (Size $6\frac{1}{2}$ in. $\times$ 8 in.)

Description of the article.....Outrigger hinges.

Particulars of Orders.									Maximum Stock.	Minimum Stock.
Date.	O/No.	Quan.	Date.	O/No.	Quan.	Date.	O/No.	Quan.		

In.	Date.	Out.	For Body No.	Balance.	In.	Date.	Out.	For Body No.	Balance.
	1912.								
100	Feb. 10	50	500	50					
	,, 12	40	500	10					
	,, 24	10	500	—					
200	Mar. 6	20	501	180					

(5) Foreman to initial time tabs when completed, and send to clerk in office.

(6) Clerk in office to enter master's cost and comparison tab and fill in box.

(7) Any work done outside for body, the same to be got from invoice and added in foot of master's tab.

Example N is one of the best stock cards at the present time. All the storekeeper has to do is to simply enter on the card what comes in and what goes out so that on inquiry at the stores at any time he can tell the stock right away from the card. These cards to be made from cardboard, size 6½ in. by 8 in., and ruled on both sides. I have entered full particulars on card, and there should be no difficulty of keeping stock and track of everything that is issued from stores. Every separate article should have a card written out for it, and kept in a little clip beside the articles. If not beside the article, they can be arranged in alphabetical order, and kept in a box. The above card is quite suitable for everything kept in stores.

Repairs.—All repairs to be treated in the same manner as new bodies. The clerk in the office to have a separate repair order book, with the same ruling as for new work, giving full particulars regarding the necessary repairs to the body, to be fully entered on same, afterwards time tabs for all departments having labour on it to be written out and sent to the foremen of said departments, material sheets to be written out and sent to the stores. In order that the time tab and material sheets should be different from new body sheets, a rubber stamp, which should not cost more than 2*s.* 6*d.*, to be as under :—

Repairs

Only.

All repair order numbers to have the letter R. after the number, so as to distinguish the number from body number. And when the clerk is making out time tabs he must put (if possible) full particulars of repairs on same, so that each department will only repair what is actually wanted. The time tabs and material sheets to be sent to clerk in office in the same way as the new body sheets. When the repairs are completed, I would suggest to put all material and time on a master's tab, same as for new bodies, for reference. Sheets and tabs used for new bodies to serve for repairs, only that they are stamped " repairs only."

I now give a statement showing non-productive charges, other charges not mentioned to be added. It is necessary to test the oncost and productive charges at least every six months. I have made out such charges for the period of six months. In order to arrive at a percentage or oncost charge, which should be added to the prime cost on master's prime cost or comparison tab, I have put down an example of how to arrive at same.

O. NON-PRODUCTIVE CHARGES (For Six Months).

	£ s. d.	£ s. d.
Non-Productive Wages		2,400 0 0
Power—		
Electric	150 0 0	
Gas	25 0 0	
Oils, etc.	10 0 0	
Sundries	5 0 0	
Water	15 0 0	
Coal	40 0 0	
		245 0 0
Packing		20 0 0
Carriage and freight		15 0 0
Designing		50 0 0
Royalties		12 10 0
Patent maintenance		10 10 0
Repairs and maintenance—		
Buildings	30 0 0	
Machinery and tools	15 0 0	
		45 0 0
General Expenses—		
Rent	100 0 0	
Rates and taxes	20 0 0	
Insurance	10 0 0	
Gas and electric light	50 0 0	
Sundries	5 0 0	
		185 0 0
Selling Expenses—		
Salaries	150 0 0	
Advertising	100 0 0	
Commissions	50 0 0	
Travelling expenses	40 0 0	
Incidental or sundries	10 0 0	
		350 0 0
Office—		
Salaries for six months	600 0 0	
Stationery	50 0 0	
Stamps, telegrams, and telephones	20 0 0	
		670 0 0
Discount allowed, less received		20 0 0
Bank charges (not interest)		30 0 0
Depreciation (should be made out according to the value or life of the machines)—		
Building	20 0 0	
Machinery and tools	50 0 0	
		70 0 0
Directors' fees (if a company)		100 0 0
Secretary's fees		250 0 0
Auditor's fees		50 0 0
Legal expenses		10 0 0
Interest on loans (bank or otherwise)		100 0 0
Debenture interest		200 0 0
		£4,833 0 0

From your wages book you find that productive labour for the period of six months amounted to £9,600.

On cost charges.	Productive charges.
£4,833	£9,600

Multiply £4,833 by 100 = £483,300 and divide by £9,600.

9,600)483,300(50⅓ per cent.

48,000

3,300

Criticism of the Essay.—A great deal of attention has been devoted in this essay to the prime cost of a certain body, and little is said about the general subject of prime costing. From the nature of the tables given I should presume that standard body-making has been reduced almost to a science in the factory he has in view. The requisition sheets that are reproduced are certainly interesting, seeing that the same body is carried through on them, and the one relating to the paint shop is a courageous way of attacking a difficult part of the costing. I should like to have known more as to the method by which the various quantities were arrived at, especially in this and the timber departments. It will be noticed that a time sheet or tab is relegated to each " job " instead of one to each " workman." I note that cards are used in place of the stock book, whereby the storekeeper is enabled to ascertain the quantities of materials of each kind on hand at any time. In the opening clause of this essay I am distinctly told not to expect much detailed explanation, and I think that the writer has been so bent on simplicity of instruction that it has led him to omit details which should have been included. I feel that had this restraint been absent, I should have been more convinced of the excellence of the system set forth. The " Summary of Details " shows that he has a grasp of the subject, and is capable of arranging his ideas in an orderly manner.

You will see by these essays that you must have a thorough business system. It is the practical man who succeeds nowadays. You must be familiar with the working side of your business, know how things ought to be done, and know how to do them yourself. Otherwise you cannot get them done well by others. Also a manager must learn how to talk directly to the point; to decide quickly in emergencies; to infuse loyalty among employés; to waste no time in non-essentials; to insist on quality in service rendered; to find and stop leaks that sap the profits; to hold heads of departments to strict account; to plan ahead, and anticipate both needs and dangers; to get rid of inconsequential callers quickly and courteously; to understand details, but leave their execution to subordinates; to promptly detect and remedy any jar or friction in the business machinery; to bear in mind that eventually there must be a satisfactory ratio between expenses

and income. It is well to remember that next to knowing your own business, it is a very good thing to know as much about your neighbour's as possible—especially if he is in the same line.

ESTIMATING FOR NEW WORK AND REPAIRS

In this department, as in all, there must be a system in order to give correct estimate, and that nothing is overlooked, or when the work is in hand it may be found to include items not contemplated at the time of charging, especially when, as is generally the case, the work is required to be done at a fixed price. A rough estimate book is carried in the pocket or allowed to be on office desk for the convenience of those whose work is to take orders.

In this book the work or particulars of new work is entered in pencil, following in this order :—

Work to be done or necessary for repairs

To—

Body. Mounting. Painting. Trimming. Accessories. Extra fittings. In the case of repairs, all the parts enumerated are carefully examined and a note made of the work required.

Under the heading of Accessories would come a particular type of windscreen, or if identification or number plate supplied. An extra would be a Stepney wheel, or electric light to the interior, etc.

In making up the estimate the prices are now entered in pencil against each item, and the whole totalled up with the addition of the necessary establishment or trade charges and the profit, and the total is the price to charge. From this rough estimate book, the estimate proper is dictated for typing or writing out and always press copied before sending to the customer, and if the work is ordered, *Ordered* is written against it in the estimate book, with the date of order against it and the date when it must be completed ; in large works this method is slightly elaborated by the addition of a special *Order Book* in which the work is entered. The estimate and order are ordinary foolscap size ruled for writing and single cash columns.

No mistakes can occur if this method is carefully followed.

Of course no prices can be given ; for instance, two coachmakers with business next door, working under precisely the same conditions with exactly the same job, the one getting £15 for it, the other £20 ; yet the one getting work at the cheaper rate may possibly be conducting his business as a paying concern, while the other may be insolvent ; it depends entirely on management, bearing in mind that to your manufacturing cost of labour and material, there is to be added the trade's charges and the profit ; hardly two manufacturers buy their material under the same conditions. one buys largely and gets good discounts, which is part of his profits. The following is a specimen copy of an " estimate and specification " for a new landaulette :—

LONDON AND COUNTY MOTOR WORKS.

MOTOR BODY BUILDERS, Tottenham Court Road, London, W.

		£	s.	d.
1913.				
Jan. 1	Estimate for Landaulette body to 16–20 H.P. Wolseley.			
	Specification :—			
	To carry 2 persons inside, and 2 in the driver's seat.			
	The front seat 3 ft. 7 in. wide, the front body pillars fixed and 2 glasses to front to fall into the framing, glasses to fall into doors with folding brass supports, all glass frames to be of polished mahogany (or walnut).			
	Slam locks to doors, with brass (or plated).			
	Oval pattern door handles and inside levers.			
	The head fitted with compensating springs, and outside head joints and covered with the best enamelled leather. A tool box under seat (or back of body if fitted with door).			
	Long steps to body 11 in. wide, covered with lino., finished with brass (or nickel) angle bead, and a set of moulded steel wings over the wheels.			
	The body securely fixed on chassis (provided), and the whole painted to colour (selected).			
	The front seat trimmed black leather, the front cushions made with rolls.			
	The body trimmed with leather (or cloth), with spring cushion, quilted with buttons.			
	Head lined with cloth to match, front and inside bottom boards covered with lino.			
	Velvet pile carpet to bottom and bottom sides, etc.			
	For the sum of 135 guineas.	£141	15	0

Appendages, etc., added as Extras.

Estimate for fitting a Double Cape Hood to an old existing body :—

LONDON AND COUNTY MOTOR WORKS.

MOTOR BODY BUILDERS, Tottenham Court Road, London, W.

1913		
Jan. 1	*Estimate* :—For making and fitting a double extension Cape Hood with four (4) hoopsticks, polished, covered with best waterproof double texture twill with edge welted in brown welting leather, with side curtains and a back celluloid light.	
	The body ironwork to carry head fittings to be carried down to the seats with flaps. All the ironwork exposed to be all over brass. The hood to have two outside head joints fitted straight.	
	The whole of the work, including the taking up and refixing of the present upholstery to be executed in the very best style and workmanship.	
	For the sum of 25 guineas.	£26 5 0

If this estimate meets with your approval, we shall esteem it a favour if you will kindly intimate the same to us, so that the work may be proceeded with.

The following are specimens of order forms used in the works which show how the work can be facilitated by the use of a systematic method.

LONDON AND COUNTY MOTOR WORKS.

BODY ORDER FORM.[1]

ORDER No. Date

For M. Per Messrs.

CHASSIS :— Number

Type
H.P.
Wheel base
Year's make
Fittings
Steering

DATE :—

Delivery of chassis
Delivery of complete car

BODY :—

Type
To seat Back Front
Extra seats
Side doors in front
Scuttle dash
Luggage grid at back
Luggage rail on top
Tool box
Accumulator box
Glass frames

Remarks :—

PAINTING :—

Body :— Chassis :—
Picked out Picked out Wings
Fine lined Fine lined Crests
Belt

Remarks :—

TRIMMING :—

Leather No. Cloth No.
Pleated squab
Cushion, plain or pleated
Pockets
Broadlace No.
Blinds
Carpet
Speaking tube Companion Card case Ash-tray
Front boards covered with
Mats
Fittings

Remarks :—

[1] This is a specimen of a Body order form card (size about 13 in. × 8 in.) and should be attached to the job as soon as it is started and should only be removed by a responsible person when the order has been *completed.*

STEPS AND MUDGUARDS :—
Steps, covered in
Polished nosing
Filled in to chassis with
Wings, front
Wings, hind

SPARE WHEEL :—
Type
Let in step

NUMBER PLATES :—
Position on front — Position on hind
Number to be painted

HOOD :—
Type — Joints
Sticks varnished — Side curtains
Material — Lights

WINDSCREEN :—
Type of screen
Make of fittings
Varnished wood

Further instructions :—

LONDON AND COUNTY MOTOR WORKS.

REPAIRS AND JOBBING WORK.

JOB NO. — DATE
For M.
Chassis. — BODY

BODYWORK :—

PAINTING :—

TRIMMING :—

FINISHERS :—

WINGMAKERS :—

SMITHS :—

POLISHERS :—

ACCESSORIES :—

Further Instructions :—

CHAPTER XLI

HOW TO TAKE AN ORDER FOR A MOTOR BODY [1]

THERE are many young men, master motor-body builders' sons and others, including those who have had practical experience in one particular department of the factory, who may be glad of a few general remarks which are made for the purpose of helping them in their early days of salesmanship. Apart from the natural persuasive manner, and an ability to put the client at ease, there are a few facts with which it is well to be armed when a new chassis has been bought and the customer has called in the absence of the manager, or perhaps the father has purposely gone out to put his boy on his mettle. I might also whisper that there are managers taking orders in some houses, who, by their want of practical training, often promise impossible things to a client, which causes many a troublesome half-hour to the draughtsman or foreman when these rash assurances have to be worked out into practical shape, and it is a very delicate task for the manager to have to be told that he has promised impossibilities, and more delicate still to have to throw cold water on the pet ideas of the motorist.

Body Dimensions and Relation to Size of Chassis.—The motor body builder is interested chiefly in the length of the chassis behind the dashboard, its width, and the position of the hind wheels. Dealing for the moment entirely with the side-entrance car, the position of the hind wheels is vital in deciding the comfort of the motor body. Motorists, when told their new chassis has a 10 ft. 6 in. wheelbase, usually jump to the conclusion that their door will be wider and open easier than their friend's car, who has only 9 ft. 11 in. of wheelbase, but that will not be so if the extra inches are utilized by the engineer in accommodating a longer bonnet, and the proportion of the wheelbase behind the dashboard, and not the total, is the part which the body-builder has to study. Two chassis with identical measurements from dashboard to hind axle need not, however, have the same scope for a side-entrance body. If one has an 880 mm. wheel, and the other a 935 mm. wheel, the front of the wheel in the large wheeled chassis will come nearer to the dashboard ; and, again, two chassis with the same diameter of hind wheels will differ in side-entrance possibilities if one is higher from the ground than the other, the higher chassis tending to be more useful. Chassis differ, again, as to the space required from the dashboard to the

[1] Reprinted, by permission, from the *Automobile and Carriage Builders' Journal*.

front of the driving seat, a matter which is decided by the position of the steering wheel and most backward position of the brake and speed levers. So, to sum up the matter, the size and position of a side-entrance doorway is decided by the position of the front of the hind tyre in relation to the dashboard, minus the measurements required to the driving seat, not forgetting the height of the chassis from the ground. The distances from the dashboard to the driving seat and the top of the chassis to the ground vary in different cars as much as 5 in., so that it is an item which cannot be overlooked ; also, some cars are higher at the back than at the front—notably the Panhard and Mercédès.

Necessary Normal Dimensions.—Having indicated where to look for the space at our disposal, one naturally asks, " How much do I want for a satisfactory side-entrance car ? " Starting from the front of the driving seat, we shall find 18 in. is none too much when the back upholstery has been allowed for, and if one desires a bucket seat, the distance that it sails out at the top must be added (often some 3 in. or 4 in.), and is a luxury which should onlybe indulged in in a car of generous wheelbase. Then before the door actually opens we shall find a pillar (the front standing pillar) which usually runs about 2 in. ; then comes the doorway itself, which should measure about 22 in. So that from the front of the driving seat to the back of the door we have 18 in. (driving seat) + 2 in. (pillar) + 22 in. (doorway) = 42 in., or, allowing for a bucket driving seat, 45 in. Now, if we glance at a few cars, we shall notice that the back line of the door and the front of the hind tyre, even when allowing for the clearance of the wing, need not be in the same straight line, and in normal circumstances our tyre line may be 2 in. in front of the back line of the door, so that our final dimension from the front of the driving seat to the front of the hind tyre stands at 40 in., with 43 in. for bucket driving seats. In the open type of car it is often unnecessary to allow the extra inches for the bucket seat as it can encroach on the interior body space without looking unsightly.

Length of Chassis.—A long chassis should have a wheelbase in proportion, so that the hind axle shall come well to the rear and support the hind seats, and prevent any unsightly and dangerous overhanging portion at the rear. An ideal body will not project beyond the square line of the back of the chassis, but a little licence is generally allowed in this direction. The usual open type of side-entrance phæton demands at least a 2 m. 45 chassis, and is also a suitable size for a small limousine. For larger open cars 2 m. 60 is a good average measurement, while sizes ranging up to 3 metres are designed for bodies with a fixed seat between the side-entrance door and the driving seat, and those where two single seats are arranged facing forward between the back seat and the side doors.

Width of Chassis.—Width of chassis is becoming of greater importance now that wide bodies are so much in vogue. " Three on the back seat " is often a stipulation in the specification of a new body, and the customer

does not always realize what relation the seating capacity for three persons bears to the width of chassis. Chassis vary from 30–36½ in., and a seat for three means at least 4 ft., and then there is only the minimum accommodation of a public seat omnibus. There are motor cars running about with bodies 4 ft. 6 in. wide, and in some cases more, bolted to chassis some 2 ft. 8 in., meaning an overhang of 11 in. each side. An elementary knowledge of mechanics will at once show the reader that a combination of this character must at least entail a great deal of side rolling as the springs give up and down to the inequalities of the road. The actual width over the springs is the real measurement which matters, and the fact that they are connected directly to the chassis means that the measurement across from one spring to the other cannot greatly exceed the width of the chassis. This overhang from the side of the chassis is not so important in an open car as in the landaulette and limousine, where the weight and height of the superstructure give a greater leverage to the rolling of the car.

What Type of Body ?—The particular pattern of body desirable is not always an easy point to settle, although, at the same time, there are not many distinct types to choose from. The open body type, known as the side-entrance phæton, is sufficiently popular to warrant its being issued as a standard body by firms such as those who manufacture the Mercédès, Clement-Talbot, Spyker, Humber, and Fiat chassis. They have two on the front seat, and room for three at a pinch on the back seat (although later patterns are improving on this), and doorway generally of minimum width. Such a body, weighing from 6 cwt. to 7 cwt., does not tax the horse-power of a chassis, is ideal as a trial body, and a fine weather car for town work and touring. However, should this type of body be ordered, the following considerations are necessary in order that the customer shall get the greatest possible convenience in the minimum of space with the least weight.

The Specification of an Open Body.—Having assured ourselves that the distance from the back of the lever quadrant to the front of the hind tyre is not less than 3 ft. 6 in., the front seat should be divided with an upholstered partition just high enough to support the elbows without preventing getting the thighs under the steering wheel. Two separate buckets are unnecessary, and only add to expense and weight, although our partition may be thick enough to allow of the inclusion of a small goggle or glove locker. If the motorist has long legs, see that the necessary allowance in the leg room (the measurement from front of cushion to pedal) is made. The back seat (holding three in emergencies) may be provided at a slight extra cost with a folding elbow rest (as in first-class railway carriages), so that when one or two are travelling in the rear portion of the car they may not be supported on one side only, a matter which counts on a long journey, and especially so to elderly people.

Locker Space.—Whether the tank feeds the carburettor by pressure or gravity will decide whether you have any locker space under the driving seat. The tank, however, will generally allow of a small narrow locker opening from the inside of the body, and will measure from 5 in. to 6 in. in depth, run the full width of the body, and have its ends rounded off so as not to interfere with the entrance to the car. If we have a pressure tank, then the space under the driving seat may be divided into two portions vertically, one side being again sub-divided into two or three small drawers for the articles of the motorist's kits. Most bodies have a locker under the hind seat, accessible from the rear. A tool box may generally be arranged out of sight, under the floor of the car, in any position the mechanism allows, part of the floor being hinged to form a lid. Tool boxes on the step, under the step, and on the hind luggage carrier, vary in size according to the requirements of the motorists.

Watertight Tool Boxes.—Be moderate as to the size these boxes shall be, especially on the steps, remembering that the most water-tight job is where the hinges are on the back of the box, a form of construction necessitating fixing the box a few inches away from the body so as to allow the lid to open, unless we have a simple lid to lift on and off, as in a cardboard box. Beware of the modern French tool box, costing almost as much as a small wardrobe. They are usually French polished to a high degree of brilliancy, with nicely rounded corners, the lid being hung on a piece of piano hinge (i.e., such as piano lids are hinged with, and is used for several purposes in the motor trade). It will be found that the water soon percolates through the interstices of the hinges, and any metal work inside will soon be ruined. A strong serviceable tool box is made of birch, the lid hinged from the back and overhanging well all round. The box is best painted to match the body, and should receive almost as much attention regarding the number of coats of paint. The brass fasteners will have a long lever, so that as the levers are pulled downwards the lid is pressed well home. It is a wise precaution to have all tool boxes and lockers provided with good quality locks and keys, especially when much touring is done.

Cape Cart Hoods.—The cape hood is not only useful when we have inclement weather to face, but in its open position acts as a valuable dust screen. The type fitted to side-entrance cars is called the "double-extension" hood, the part protecting the front seat being made detachable, and capable of being transferred to the hind protecting portion and all folded down together. There are also several on the market known as the "one man" hood, which only requires one person to put them up or down; the former necessitates a person each side, so as to lift the front detachable part back on to the hind portion, while the latter is void of this front portion, and is constructed with a long trellis extension from the hind sticks. Even if a cape hood is not decided at once, there is very little expense incurred in having the irons fitted ready to receive it. These irons or props can then

be fitted and fixed before the car is upholstered—a far better plan than ripping up the leather and fitting them afterwards. Cape hoods have generally three sticks in front and two behind, an arrangement which, in most cars, distributes their bearing fairly equally in supporting the open hood, and at the same time keeps them free of the side entrance and short in length, so that they shall not project unduly at the rear. A long car will probably require three sticks at the back, making six in all. It is now fashionable to have a further extension forward to the cape hood, consisting of a portion sliding on the inside of the front stick, its object being to well protect the front seat and wind shield if used. A first-class hood will be provided with curtains all round and celluloid windows, the front side ones being a legal necessity in London. A roll-up curtain behind the driver's seat, also provided with ample windows, will be found an additional protection, and the hood should be so designed that the curtain hangs from one of the sticks of the cape cart hood, and for this reason the back of the second or third stick will come immediately in line with the back of the driving seat.

The Closed Body.—Under the heading of closed bodies may be included those which are capable of opening, such as the various styles of landaulettes, as well as the brougham and limousine types. Generally speaking, this is the type of body in which the driving seat cannot encroach on to the body space, and for that reason the wheelbase of the chassis will want more closely watching than is the case with the side-entrance type described at the beginning of this chapter.

The Doorway of a Single Landaulette.—The single landaulette is now known to a wider public in the shape of a taxi-cab, which may be taken as a sample of what can be produced in this style of body at the minimum of cost. In a private landaulette we should allow at least 18 in. for the driving seat, and 22 in. for the doorway, which latter should not have anything cut away at the bottom right-hand corner to clear the wing without the customer being fully acquainted before hand of this intended modification. Some will argue that it is better to have a doorway partly cut away at the bottom, in conjunction with a more comfortable width at the elbow line, than to sacrifice everything to the æsthetic point of view and insist on a properly defined bottom sweep to the doorway. Many of the latest patterns of taxicabs have their doorways cut away as suggested, which goes to show that the practice is essentially a practical one, which makes the best possible use of the space at the designer's command. On the other hand, it should not be considered necessary to use up every inch of the measurement between the dashboard and hind wheel.

A Long Body means a Large Headroom.—It is most probable that the customer will suggest a large body to hold four persons sitting *vis-à-vis*. This at once will affect the necessary leg-room, and leg-room is a great factor in determining overall length. As the door will probably have to

be designed within a practical margin as to dimensions, it follows that any great demand for length in the body will decide the headroom, in order to get the folding leather work of the head to fall and properly clear the top of the back squab, so as not to cause discomfort to the occupants. Inquiry should be made as to whether the body will often carry the maximum number, or whether the two extra seats are only for occasional use. If the latter, it will be unnecessary to construct a large body.

The Advantages of a Small Body.—The motor body builder is decidedly enhancing his own reputation if, when taking instruction from his client, he does his utmost to let him see the great disadvantages of large bodies apart from the motor manufacturer's considerations. With a body of normal dimensions, where no space is wasted, the general effect is neater, the wear and tear is considerably less, and it will be in most cases properly suspended with relation to the hind axle. The proper function of a large body is well illustrated in the dress and state carriages used on important occasions, when the generous proportions give dignity and distinction to a vehicle in keeping with their particular use.

Minimum Turnunder.—The desire to keep the body as short as possible is no less important than an eagerness to obtain a width of body in keeping with it. As I have already remarked, a closed body has a greater leverage to produce side rocking. In limousines and landaulettes a wide body at the standing pillar will often produce an ugly side sweep and turnunder, especially the latter, in the endeavour to escape the position of the hind tyre and wing. A large turnunder means extra work in obtaining the falling of the front lights, and heavier timber or " slabbing " of the pillars, and sometimes giving a decided twist to the line of the toe of the front standing pillar. It also increases the risk of the doors being badly hung, as the bottom outriggers have to be longer, and the door, when opened, covers up a considerable portion of the entrance by reason of its shape. Provincial motor body builders should also remember that a minimum of turnunder was considered part of the style of a carriage, turned out by West End builders in London, but one regrets to say that style in many well-known establishments is not so apparent in the motor body as in the horse-drawn carriage. Fifteen years ago one might sit in Hyde Park and tell the names of the makers of the vehicles as they passed, but there is now a considerable difficulty in repeating the experiment with motor body work, although individuality reigns here and there.

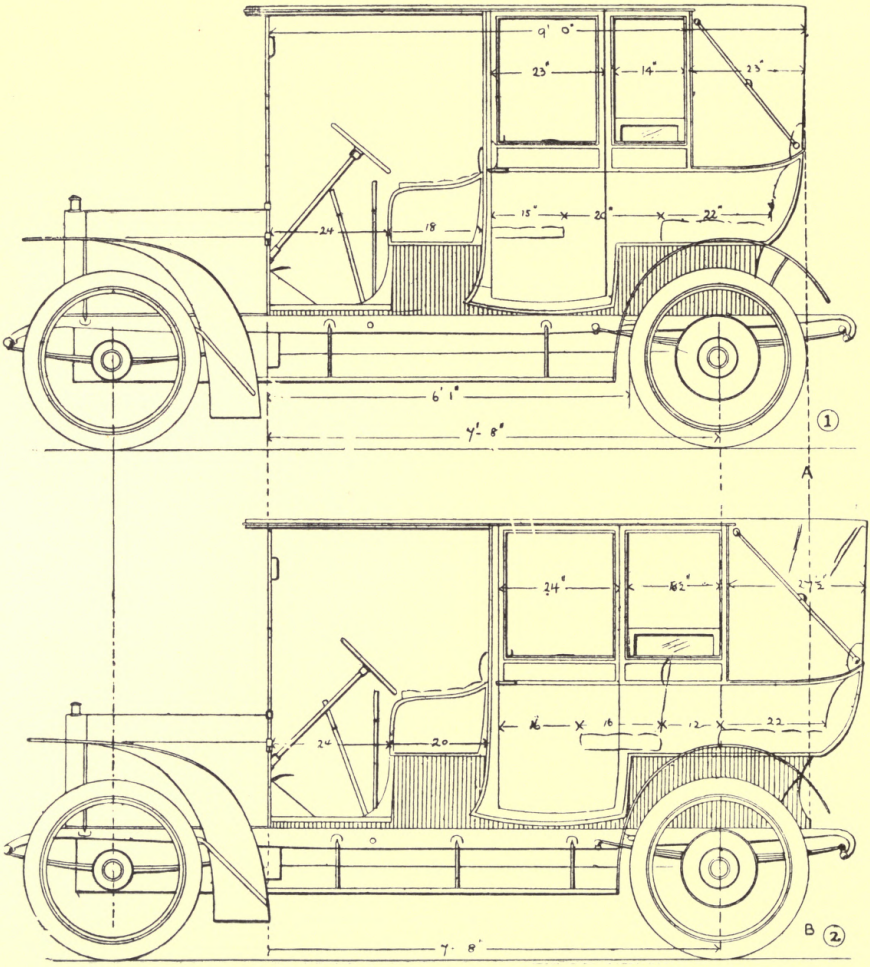
Minimum Side Sweep.—A minimum of side sweep has also the support of the leading houses. Side sweep is intended primarily with a view to eliminate a flat surface, and not in any way a striving after the spherical. Some builders apply the same principle to the back panels, and there is no reason why a little fulness across the front of the body should not produce results equally as good. The main idea is that a flat surface tends to look

hollow, and a little fulness will counteract this, but the desired effect is lost if the feature is in any way exaggerated. A generous side sweep also necessitates extra timber in the side framing, so long as flat drop glasses are used. Another advantage of a body of medium width is that it can be built between the wheels, and by bringing the seat line close to the floor one can have a deep cushion, inquiries for which are on the increase, as ladies are beginning to expect the same comfort in their motor bodies as in the armchair in the drawing-room. The seatboard must be on a level with the seat bottom-side, so that the cushion may lie right up to the panels. The practice of bringing the hind wing above the line of the bottom-side is condemned by some as breaking up the outline of the body. On the other hand some builders, especially the French, are of opinion that this " breaking up " is just the thing to be desired.

The Limousine Landaulette.—This now popular type of body is often called a double landaulette, or a ¾ landaulette, and it is, therefore, necessary to be quite sure which variety of landaulette is required when either of these latter terms is used—names which not only contradict one another, but before the advent of the limousine landaulette belonged to quite a different style of body. Here, again, the advantages of the particular design are often swallowed up by a desire to obtain maximum accommodation. The limousine landaulette is intended as a means of providing a large landaulette on a comparatively small wheelbase, as the extra space is provided behind the doorway. For this reason we shall have to be very careful to see that the body does not unduly overhang at the rear. The best measurement of chassis is the one which, being just too small for a double landaulette, takes a medium-sized limousine landaulette, giving sufficient wheelbase for the door to be well clear of the wing and the side light slightly forward of that position. Sketch No. 1 (Plate L) shows a limousine landaulette with the body kept within the wheelbase. It will be noticed that the hind seat is centrally placed over the hind axle, while the seats on the front lining boards are almost between the axles. Contrast this with Sketch No. 2 (Plate L) which is by no means exaggerated. Here the hind seat is entirely behind the hind axle, and a considerable portion of the body is causing needless wear to the hind tyres. The position of the extra seats in No. 2, while encroaching on the door gangway, curtails the knee-room in front of the back seat. Both bodies are drawn on a chassis of the same measurements, and the leading dimensions of each body are given.

Extra Seats in the Limousine Landaulette.—Unless the chassis is nearly large enough to take a double landaulette, the extra seats should be fitted to the lining boards. The builder will do well to have some of the leading types of seats fixed up in his office, so that the working of the mechanism may be readily shown to a client. The simplest forms are the best, and are most likely to give satisfaction to the motorist by reason of their being unlikely to get out of order. Seats which bring the passenger's back

PLATE L.



against the door have the advantage of not encroaching greatly on the knee-room of the main hind seat, but require safety locks to the side doors in case of accidents. A properly upholstered back, combined with a flapped seat and a removable cushion, has the advantage that it can be made on the premises, and made absolutely to the measurements of the particular car and the wishes of the client. Seats which face forward demand a great deal of leg-room ; if they fold they generally form a clumsy bundle on the side of the body, and if of the armchair type are a serious obstruction on the floor of the car. Until the advent of the motor body, practically all broughams, landaus, sociables, double victorias, etc., were built on the *vis-à-vis* plan, and suggested that sociability amongst the occupants was the first thing to be striven after rather than a forward view of the passing scenery. One can see the charms of the country equally as well from a seat with its back to the engine, although in most chassis it is impossible to give it the same generous measurements, and consequently an equal amount of comfort, as the back seat.

APPENDIX A

THE METRIC SYSTEM.

10 millimetres (mm.)	= 1 centimetre (cm.)	=	·3937 in.
10 centimetres	= 1 decimetre (dm.)	=	3·937 in.
10 decimetres	= 1 metre (m.)	=	3·281 ft.
10 metres	= 1 decametre (dm.)	=	32·81 ft.
10 decametres	= 1 hectometre (hm.)	=	328·09 ft.
10 hectometres	= 1 kilometre (km.)	=	·62137 mi.
10 kilometres	= 1 myriametre (mm.)	=	6·2137 mi.

METRIC CONVERSION FACTORS.

Km. ×	3,281	=	ft.
m. ×	39·37	=	in.
m. ×	1·094	=	yd.
cm. ×	·3937	=	in.
cm. ÷	2·54	=	in.
mm. ×	·03937	=	in.
mm. ÷	25·4	=	in.
sq. m. ×	10·764	=	sq. ft.
sq. cm. ×	·155	=	sq. in.
sq. cm. ÷	6·451	=	sq. in.
sq. mm. ×	·00155	=	sq. in.
sq. mm. ÷	645·1	=	sq. in.
cu. m. ×	35·3145	=	cu. ft.
cu. m. ×	1·308	=	cu. yd.
cu cm. ÷	16·383	=	cu. in.

APPENDIX B

CITY AND GUILDS EXAMINATION SYLLABUS, 1909.

ROAD CARRIAGE BUILDING, INCLUDING MOTOR CAR BODY WORK.

The examination in the Ordinary Grade will be a written examination; the questions will refer to carts, light open carriages, and open motor car bodies. Simple drawings will be required.

In the Honours Grade (1) specimens of work must be submitted by the candidates before the examination; (2) the written examination may include questions with regard to any type of carriage or motor car body, and drawings will be required to illustrate the answers to some of the questions; (3) a special drawing and specification, etc., relating thereto will be required after the written examination, to be done in the candidate's own time, but completed by a given date.

At the written examination in either grade, drawing paper will be provided by the Institute, but candidates must bring their own drawing instruments. No curves or patterns will be allowed.

Ordinary Grade.

I. *Syllabus.*—The examination questions will be founded on the following subjects, which are arranged as for a two years' course of instruction. If two sessions, however, are given to the preparation for the Ordinary Grade, the subjects in brackets may be taken in the second year's course.

1. Timber—used in coachbuilding or motor bodies. Structure of a tree—Method of seasoning. Purposes for which various timbers are used—Countries from which we obtain timber.

(Measurement of English and foreign timber in the log and plank, artificial seasoning, timber bending, marking out and sawing timber.)

2. Iron and steel, nature of; process of welding and forging. (Tensile strains and strength of iron and steel.)

3. Designing open carriages and motor bodies, and requirements as to seat room, leg room, position of springs and wheels.

(Designing phæton heads, cape hoods, and canopies.)

4. Undercarriages and shafts for two-wheeled carriages and light four-wheeled carriages.

(Sizes of shafts, poles, and bars for all carriages adapted for horses of various sizes; position of breeching and kicking strap staples.)

5. Joints used in carts and light carriages (in all classes of carriages and open motor cars).

6. Manufacture of wheels, including artillery pattern—Methods of hooping (Varieties of tyres used, rubber tyres and pneumatic tyres, and boxing wheels.)

7. Axles, varieties of—how to set axles true.

(Motor axles and ball-bearing axles, manufacture of axles and axle boxes.)

8. Springs. Reason for applying springs to carriages. Varieties of springs used. Spring making.

(Essential qualities of good springs, testing, and methods of fixing to carriages.)

9. Ironwork used in light carriages.

(Edge plates and fitting and fixing them.)

10. (Brakes, lever brakes, foot brakes, etc. Brake blocks.)

11. Painting, materials used, methods of mixing and of painting.

(Composition of paint, varnish, japan, gold size.)

12. Trimming materials, leather, cloth, canvas, lace, etc.

(Preparation of leather, marking out squabs, making cushions, etc., marking out leather and the methods of measuring leather.)

The written examination in both grades will be held on Thursday, April 29, 7 to 10 p.m. The fee for the entire examination in the Ordinary Grade is 1*s.* 6*d.*, in the Honours Grade 2*s.* 6*d.*

HONOURS GRADE.

(*1*) *Written Examinations.*—In the Honours Grade examination more difficult questions will be set in the above subjects, and the questions may apply to any kinds of carriage or motor car body. Some knowledge will also be required of:—

1. Design and construction of bodies, carriages, and wood and iron perches.

2. Strength of materials generally used.

3. Making various patterns of wheels, proportionate strength of spokes, felloes, etc., and sections of tyres used for carriages and motor cars for light and heavy loads.

4. Framing of landau bodies, brougham bodies, motor car bodies, etc.

5. Motor car bodies, closed and open, the use of aluminium and other metals for panels, wings, and mouldings, etc., the use of built up panels and boards.

6. Framing and hanging doors, making folding hoods, landau heads.

7. Testing materials, as wood, iron, cloth, etc. Testing springs, axles, and finished carriages.

8. Arranging and fixing lamps, both for outside and inside use, wiring electric lamps; various fittings, such as locks, turn-buttons, hinges, etc., used for carriages and motor bodies.

9. Strains to which carriages and motor car bodies are subject, and how to provide against them.

10. Writing out orders for workmen, making working drawings with the necessary sections for use in the shops—quantities of cloth, leather, lace and other materials required.

11. How to cure defects in bodies or carriages, or repair damage caused by accident, or wear, and to stop noise and vibration.

12. The measurements of the chassis required by the motor body builder; the English equivalents of the metre and its subdivisions.

(*2*) *Drawing.*—**Candidates in the Honours Grade will be required to prepare a design,** the data for which will be given at the time of the written examination. The design to be worked out and drawn and the drawings, with description, calculations, etc., to be returned to the offices of the department **not later than Wednesday, May 12.** A certificate signed by the candidate's employer, or by the class teacher and a member of the School Committee, stating that the work has been executed by the candidate himself, without assistance, must be forwarded with the drawing. In cases where the work has been executed at the candidate's own residence, a statutory declaration will be required. Forms for either the certificate or the declaration may be obtained on application. Candidates, in addition to the ordinary mathematical instruments, may use wooden patterns.

(*3*) *Specimen Work.*—**Every candidate will be required to forward, not later than April 26, a specimen of work executed during the twelve months preceding the examination.** A bodymaker (carriage or motor) will be expected to send in a specimen of woodwork (for example, one or more joints used in body making); a painter should forward a small portion of a finished panel; a draughtsman should forward drawings; and a candidate engaged in the office should send in a specimen of detailed costing as applied to the manufacture or repair of a carriage or motor.

The specimen of work should not, in any case, exceed a cubic foot in dimensions. It must be accompanied by a certificate or declaration, as required for the drawing executed under (2).

APPENDIX C

CITY AND GUILDS OF LONDON INSTITUTE.

DEPARTMENT OF TECHNOLOGY.

TECHNOLOGICAL EXAMINATIONS, 1912.

47.—ROAD-CARRIAGE BUILDING.

GRADE I.

Thursday, May 2, **7** *to* **10.**

INSTRUCTIONS.

The use of scale rules and drawing instruments is allowed. Drawing paper is supplied.

Twelve questions only to be attempted.

To pass *first class*, the single brougham or the two-seater car drawing must be carefully made; the alternative question, viz., the drawing of a panel car, is intended for younger students and will only qualify for a second-class pass. Not more than an hour and a half should be given to the drawing.

1. Draw the side and half back views of a two-seater motor body. Wood panels and a box behind for a spare wheel. The diameter of the steering-wheel to be 16 in. The distance from the bottom of this wheel to the dash 25 in., and 30 in. from the chassis. Body space 8 ft. 6 in., dash to centre of back wheel 7 ft. 5 in., and wheel base 10 ft. 3 in. Scale, 1½ in. to the foot. (*85 marks.*)

or,

Draw the side and half back views of a doctor's single brougham. Scale, 1½ in. to the foot. (*85.*)

or the following, which, however, will only qualify for a second-class certificate.

Draw the side and half back views of a panel car, with bent top sides. Size suitable for a cob 14·2 hands high. Scale, 1½ in. to the foot. (*50.*)

2. A landau weighs 6 cwts. in front and 5 cwts. at the back, calculate the distance of the centre of gravity from the front axle if the coupling is 8 ft. 6 in. If loaded with six people, will their weight be equally divided between the front and hind axles? If not, give your reasons. (*20.*)

3. Describe how you can tell the difference between hard and soft ash by the bark and by other means after it is cut. What kind would you use for body

work and what for carriage poles ? Why is steam bent ash not so durable as that cut out of the solid ? (*20.*)

4. Describe the dressing up, the bending and the fixing of the back panel of the front seat of the car named in question 1. What would you do to make it keep its shape ? (*25.*)

5. Sketch to 1½-in. scale a Victoria hood for the above two-seater. This hood to be covered with leather and fitted with outside joints. (*25.*)

6. Why do you give dip and foregather to a carriage axle ? Describe how you would prevent the screwed ends of a Collinge axle breaking off when the arm is being welded. (*25.*)

7. Describe the forging of the outside head joints for the hood named in question No. 5. What size of iron would you use, and how would you obtain your lengths ? (*25.*)

8. What is priming made of ? How does it preserve the wood, and why does it not answer equally well for aluminium ? (*25.*)

9. What special care is required in the varnishing of a car which is painted a light colour ? If you made the varnish specially, what difference would there be in the materials used for your varnish and ordinary varnish ? (*25.*)

10. Sketch the two cushions and back of a two-seater. Mark the sizes and estimate the cost of the leather required, at, say, 1*s.* 2*s.* per square foot. (*25.*)

11. Describe the trimming of the Victoria hood. Say in what direction you would make the nap of the cloth to brush. Describe the sewing of the head leather. (*25.*)

12. How would you fix a spare tyre so that the use of the offside front door would not be prevented ? (*20.*)

13. Sketch in perspective a step tool-box, and describe what parts you would dovetail and how you would hinge the lid to keep water out. (*20.*)

14. Define pig-iron, cast-iron, brass, gun-metal, aluminium and copper, and state what minerals they are obtained from. (*20.*)

15. If a customer brought a brougham to you to have the front carriage bored on 6 ins. further back, what difficulties would you expect to encounter, and how would you surmount them ? Would it be easier for the horse after the alteration ? (*20.*)

Final Examination.

Thursday, May 2, **7** *to* **10.**

Instructions.

The use of scale rules and drawing instruments is allowed. Drawing paper is supplied.

Twelve questions only to be attempted.

To pass first class, the first and second questions must be attempted.

Candidates must have already forwarded to the Institute the required specimens of their work.

Candidates will receive, after the Written Examination, a paper of data and instructions for the separate Drawing Test, to be finished and forwarded to the Institute not later than Wednesday, May 22.

1. A motor 'bus which has been in use two years is sent in for repairs, the following complaints being made :—(1) Wet comes in at the let-down side windows ; (2) there is not enough head room inside ; (3) the single step at the back is too high ; (4) the aluminium panels are indented and need re-painting ; (5) the leather cushions and backs are hard with the wet. Report what you would do to make a satisfactory job. (*35 marks.*)

2. A motor body costs, say, £50 for productive labour and £50 for materials. To arrive at the manufacturing cost, trade and establishment charges must be added. What items do you include under these two heads ? Show how you ascertain the percentage of these, and how you apportion it to the labour and materials. (*15.*)

3. Show, by sketches to a scale of 1½ in., two methods of overcoming the difficulty of a long quarter for a cabriolet head. Say which method you prefer and give your reasons. (*15.*)

4. Sketch, in perspective, a limousine roof with canopy over driver, and the back of roof rounded and carried down all in one to the elbow line. Describe how you would frame it up and make it strong enough to carry a spare tyre.

Or, alternatively,

Sketch in perspective the roof of a gentleman's omnibus including roof seat, and show the framing necessary when heavy luggage has to be carried. (*15.*)

5. Describe the painting of the body of the limousine or the omnibus in *café-au-lait* colour, giving a list of the coats and the time each would take to dry. (*15.*)

6. Suppose the door was indented and you had 7 days to remove the bulge and repaint it, give a list of the coats. (*15.*)

7. Describe in detail the trimming of the limousine (Question 4). What materials and what quantities would you use and what parts would you have in polished wood ?

Or, alternatively,

Describe in detail the trimming of a gentleman's omnibus to hold eight persons inside. Give quantities ; the cushion tops and borders and back squabs being in morocco, the remainder in cloth, 60 in. wide. (*15.*)

8. Supposing a limousine door and front casing is trimmed with broad lace on rounded laths, how would you allow for sufficient clearance for the inside handle and for it fitting squarely on the door ? (*15.*)

9. Assuming that your customer was not particular as to cost, what extra fittings would you employ for (1) ventilation, (2) warmth, (3) light, (4) maps, and parcels, (5) communication with driver, (6) night travelling ? (*15.*)

10. Describe the forging of the wing stays and the step stalks of the foregoing limousine. Give sketches and mark the welds and sizes. (*15.*)

11. Describe in detail the ironing up of the body including a plate with sockets to take two auxiliary revolving seats and two folding steps to the roof. Sketch the plates and mark the sizes.

Or, alternatively,

Describe in detail the ironing of a gentleman's omnibus with roof rails and folding back rest stays to the roof seat. (*15.*)

12. Explain how a car on easy springs is of lighter draught than one on very stiff springs, and what advantage is gained by adding shock absorbers to the latter. (*10.*)

13. Calculate the weight and cost of an oak tree, the girth of which at the top end is 3 ft. and at the bottom 3 ft. 9 in., with a length of 14 ft. The specific gravity of oak is 0·394 and the price 7*s.* per cubic foot. (*10.*)

14. Sketch, to $\frac{3}{4}$-in. scale, a two-seater body for a chassis having a steering wheel 16 in. diameter. Distance from the dash to the bottom of the wheel 25 in. and 30 in. from the chassis. Body space 8 ft. 6 in. Dash to centre of back wheel 7 ft. 5 in. Wheel base 10 ft. 3 in. What would you do if the customer complained that the driving wheels slipped on the greasy roads ? (*10.*)

15. Convert the sizes of this chassis as given above to metric measurements (*10.*)

Final Examination.

(Drawing Examination.)

May 2 to May 22.

This paper to be given to candidates for the Final Examination at the close of the Written Examination on Thursday, May 2.

Instructions.

The design must be worked out and drawn, and the drawings forwarded not later than Wednesday, May 22, to the Department of Technology, City and Guilds of London Institute, Exhibition Road, London, S.W.

[For statement as to Certificate, see 46, Mechanical Engineering Final Examination, Practical, Section A.]

Candidates, in addition to the ordinary drawing instruments, may use wooden patterns or templates *if made up by themselves to their own freehand outlines.* The drawing should be finished in ink.

Make a drawing, such as you would show to a customer, of a double enclosed car or saloon to hold seven persons. Glass window at the back of driver made to fall. Size of chassis same as given in question No. 14 of the Written Examination, viz. :—Steering wheel, 16 ins. diameter. Distance from the dash to the bottom of the wheel 25 in., and 30 in. from the chassis. Body space, 8 ft. 6 in. Dash to centre of back wheel, 7 ft. 5 in. Wheel base, 10 ft. 3 in.

Give the side view, plan and section through the middle, showing the steering column, floor boards, seats and cushions.

or,

A gentleman's omnibus to carry eight persons inside and having a roof seat.

47.—ROAD CARRIAGE BUILDING, 1913.

GRADE I.

Thursday, May 1, **7** *to* **10.**

INSTRUCTIONS.

The number of the question must be placed before the answer in the worked paper.

The maximum number of marks obtainable is affixed to each question.

The use of scale rules and drawing instruments is allowed. Drawing paper is supplied.

Three hours allowed for this paper.

Twelve questions only to be attempted.

To pass *first class,* the horse or motor wagonette drawing must be carefully made ; the alternative question, viz., the drawing of a gig, is intended for younger students, and will only qualify for a second-class pass. Not more than an hour and a half should be given to the drawing.

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1. Make a drawing of a station wagonette body on a straight chassis, width 3 ft., dash to end of frame 8 ft. 2 in., dash to centre of hind wheel 7 ft. 2 in., height of wheels 33 in., top of chassis from ground 26 in. Sitting accommodation for seven passengers and a driver. High doors to the driving seat. (*85 marks.*)

or,

Make a drawing of a horse-drawn wagonette mounted on its wheels and springs, to carry the same number of passengers. (*85.*)

or the following, which will, however, only qualify for a second-class certificate.

Make a drawing of a Stanhope gig mounted on its wheels and springs. (*50.*)

2. Show by a drawing how you obtain the length of a gig pillar. Describe how it is dressed up and the tools that are used. (*25.*)

3. Draw a limousine door with a frameless glass window, and show how, by some arrangement of springs or levers, the weight of the glass can be reduced when it is being lifted. (*25.*)

4. Describe the differences of bark, grain, hardness and elasticity of the two varieties of English ash used in coachbuilding, and state which you would use for carriage poles or shafts and which for body framing. Also state from which part of a plank a door pillar should be cut, and give your reasons. (*20.*)

5. The sides of a wagonette have to be of figured elm finished in the natural colour of the wood. Describe the filling up and varnishing process, and state the time necessary to make a good job, showing no grain. (*25.*)

6. A steel mudguard painted yellow chrome is sent into the paint shop after having some bulges hammered out of it. Three days are allowed to finish. Describe what you would do to make it like new again. (*25.*)

7. What colours would you mix to produce the following shades : (1) flesh colour, (2) French grey, (3) olive green, (4) salmon colour, (5) buff colour, (6) tan colour ? (*20.*)

8. If the motor wagonette body (Question 1) is trimmed with 54-in. repp, how many yards will it take ? Describe the making of the cushions and backs. (*25.*)

9. Describe the trimming of a canopy top for the wagonette (Question 1), i.e., a top with a wood roof on iron supports and side and end curtains to roll up. If white lead is not allowed to be used for coating the wood roof before it is covered with moleskin or canvas, what would you use instead of white lead? Also describe how the curtains would be fitted to overlap and roll up. (*25.*)

10. Sketch a folding dickey seat for two persons and describe the trimming. The cushion, back and side rails are all to be covered with leather. How many square feet will be necessary? (*20.*)

11. Describe the forging of the hind steps and seat rails for the horse wagonette in Question 1. (*25.*)

12. Make a drawing of the hind elliptic springs for the horse wagonette, Question 1, 1½-in. scale, and describe the forging and tempering of the plates. (*25.*)

13. Make a rough sketch of a lever brake suitable for the horse wagonette in Question 1. Mark the sizes, and from such sizes calculate the pressure of each brake block on the wheels, supposing the driver exerts a pressure of 20 lb. (*20.*)

14. What is meant by (1) a stream line body, (2) a rotund wing, (3) a V-shaped windscreen, (4) a well-cushion, (5) a slam lock, (6) a lever lock, (7) an elbow rail, (8) a seat rail, (9) a door rail, (10) an outrigger hinge? (*20.*)

15. Explain the difference between the steering of motor cars and horse carriages, and give the advantages and disadvantages of the former. (*20.*)

Final Examination.

Thursday, May 1, **7** *to* **10.**

Instructions.

The number of the question must be placed before the answer in the worked paper.

The maximum number of marks obtainable is affixed to each question.

The use of scale rules and drawing instruments is allowed. Drawing paper is supplied.

Three hours allowed for this paper.

Twelve questions only to be attempted.

To pass first class, the first and second questions must be attempted.

Candidates must have already forwarded to the Institute the required specimens of their work.

Candidates will receive, after the Written Examination, a paper of data and instructions for the separate Drawing Test, to be finished and forwarded to the Institute not later than Wednesday, May 21.

---

1. Suppose that—owing to side-slip and collision—either a motor or horse-drawn new three-quarter landaulette was turned over on its side. Give a list of the probable repairs necessary to make it like new under the following heads:—(1) Wood and iron, (2) painting, (3) trimming, (4) accessories. How long would the repairs occupy? How would you test the car (engine excluded) when finished? (*35 marks.*)

2. If the coachmaking materials used in the fitting up of a chassis cost £10 and labour costs £5, what amount would you add for standing charges to arrive

at the prime cost of the job ? Give a list of the items included under standing charges of a motor body and coachbuilding establishment. (*15.*)

3. Give a sketch, 1½ in. to the foot, of the head of a landaulette when up. Show by dotted lines how it falls when opened, and where it rests when down. (*15.*)

4. Show by a drawing how you obtain the angle of the shut pillar of this landaulette, and describe with sketches what fittings you would use to prevent the doors rattling. (*15.*)

5. Sketch two detachable auxiliary seats with folding back rest suitable for this landaulette body. Show how they fold, where they are placed when not in use, and the extent of the space they occupy. (*15.*)

6. What is your opinion about (1) leadless priming, (2) leadless filling-up, (3) leadless colours ? So long as white lead has to be used in the paint shop, what precautions would you suggest for the prevention of lead poisoning ? (*15.*)

7. Give a list of the coats of paint from the bare wood formerly given for a best job—say on a limousine body—and compare it with the modern method used of air-drying enamels, and state the advantages and disadvantages of each method. (*15.*)

8. Describe the cutting out and the trimming of the two auxiliary seats mentioned in Question 5, and calculate the cost of the leather required at 1*s.* 2*d.* per square foot. The seats are to be squabbed and the open back rest rail covered. State also the number of hours it should take for cutting out, sewing and trimming complete. (*15.*)

9. By what means can we give more than the ordinary degree of comfort to the two people sitting on the main hind seat of the landaulette referred to above ? Sketch a section showing floor and roof and slope of back and cushion, and give the sizes suitable for a lady 5 ft. 7 in. high. Describe the cutting out of the cloth, stuffing, number and size of springs in cushion and back. (*15.*)

10. Sketch and give approximate sizes of a buffalo hide, a morocco skin and an enamelled seal skin. How do you measure them to obtain their area, and what flaws do you look for and avoid in cutting them up ? (*10.*)

11. Sketch to 1½-in. scale the front and back scroll irons for a 4-ft. hind spring, suitable for a private horse-drawn omnibus. Describe how you would forge the scrolls, the size of iron you would use and the dimensions of the bolts you would fix them with in either case. (*15.*)

12. Illustrate three methods of attaching steel mudguards to the wing stays, and give the advantages and disadvantages of each method. (*15.*)

13. In an all-metal side entrance body, sketch the sections you would recommend for the framework, and describe how the props would be fixed for the cape hood, and also the method for fixing the trimming. (*10.*)

14. Calculate in gallons the capacity of the following petrol tanks :—(1) a rectangular tank measuring inside 762 by 229 by 229 millimetres ; (2) a cylindrical tank 762 millimetres long by 229 millimetres diameter. 1 gallon equals 277·273 cubic inches. (*10.*)

15. A saloon body, with inside driving seat, is required for a special customer. State what suggestions you would make in designing it so as to reduce (1) weight, (2) wind resistance, (3) height of roof, (4) dust nuisance, both inside and to the public. (*10.*)

Final Examination.

(Drawing Examination.)

May 1 to May 21.

This paper to be given to candidates for the Final Examination at the close of the Written Examination on Thursday, May 1.

Instructions.

The design must be worked out and drawn, and the drawings forwarded not later than Wednesday, May 21, to the Department of Technology, City and Guilds of London Institute, Exhibition Road, London, S.W.

A certificate signed by the candidate's employer or by the class teacher and a member of the School Committee, stating that the work has been executed by the candidate himself, without assistance, *must be forwarded with the drawing.* In cases where the work has been executed at the candidate's own residence, a statutory declaration will be required. Forms for either the certificate or the declaration may be obtained on application to the Institute.

Candidates, in addition to the ordinary drawing instruments, may use wooden patterns or templates, *if made up by themselves to their own freehand outlines.* The drawing should be finished in ink.

Make a drawing to $\frac{3}{4}$ in. scale, such as you would show to a customer, of a streamline saloon with inside driving seat to hold four persons. Importance is attached by the customer to reduction of the weight, of wind resistance, of height of roof, and of dust nuisance. Sizes of chassis :—Steering wheel, 16 in. diameter ; distance from the dash to the bottom of the wheel 30 in., and 23 in. from the chassis ; body space, 8 ft. 11 in. ; dash to centre of back wheel, 7 ft. 6 in. ; wheel base, 10 ft. 11 in.

Give the side view, plan and section through the middle, showing the steering column, floor boards, seats and cushions.

or,

A horse landaulette to carry four persons inside.

APPENDIX D

GLOSSARY OF TECHNICAL TERMS

English.	French.[1]
The Trade—	
Carriage builder	carrossier
Coachbuilder	carrossier
Coachmaker	carrossier
Carriage manufacturer	carrossier
Wheelwright	charron
Van builder	charron
Cartwright	charron
The Firm—	
Company	*société anonyme*, *compagnie*
and Co.	et cie.
and Sons	et fils, et ses fils
and Nephew	et neveu
Limited company	société anonyme à responsabilité limitée, société en commandité
Junior (eldest son)	fils aîne, aîne
Brothers	frères
Officials and Staff—	
Board of directors	conseil *d'administration*
Chairman	président
Solicitor	avoué
Managing director	administrateur délégué
Auditor	vérificateur, inspecteur de comptabilité
Staff	personnel
Committee	comité
Sub-committee	sous comité
General manager	directeur général
Traffic manager	chef de l'exploitation
Works manager	chef du service des ateliers
Draughtsman	dessinateur
Clerk	commis

[1] Feminine Nouns in italics.

English.	French.[1]
Chief clerk	chef de bureau
Workman	ouvrier
Foreman	contremaître
Timekeeper	surveillant
Watchman	garde
Carman	camionneur
Smith	forgeron
Fitter	ajusteur
Pattern maker	modeleur
Body maker (Joiner)	menuisier
Painter	peintre

Office Terms—

Cash book	livre de *caisse*
Ledger	grand livre
Journal	journal
Day book	brouillard
Waste book	brouillard
Express train	train à *grande vitesse*
Goods train	train de *marchandises*
Carriage paid	franco post
Carriage forward	post à payer
Free on board	franco bord
Consigner	expéditeur
Consignee	destinataire
Returned empty	retour à vide
Cartage	camionnage
Empty	vide
Loaded	chargé
Gross weight	poids brut
Net weight	poids net
Invoice	*feuille* de *route*
Consignment note	*déclaration* d'*expédition*
Advice note	*lettre* d'*avis*
Label	*étiquette*
Order form	bon de *commande*
Account	*facture*
Receipt	*quittance*

Drawing Office Terms—

Height	*hauteur*
Thickness	*épaisseur*
Clearance	jeu
Centre to centre	d'axe en axe
Elevation	*élévation*
Front elevation	*élévation* de *face*

[1] Feminine Nouns in italics.

English.	French.[1]
Front view	*vue* de *face*
Side elevation	*élévation* de côté
Side view	*vue* de côté
Tools—	
Bench	établi
Trestle	tréteau
Saw	*scie*
Plane	rabot
Jackplane	riflard
Chisel	ciseau
Cold chisel	ciseau à froid
Hammer	marteau
Mallet	maillet
Gouge	*gouge*
Screwdriver	tournevis
Gimlet	*vrille*
Axe	*cognée*
Hatchet	*hache*
Auger	*tarière*
Adze	*herminette*
Punch	poinçon
Drift	*broche*
Vice	étau
The jaws of the vice	les *mâchoires* de l'etau
Callipers	compas de calibre
Plumb line	fil à plomb
Tap and die	taraud et dé
Grindstone	*meule*
Wire brush (scratch brush)	*gratte-brosse*
Circular saw	*scie circulaire*
Band saw	*scie* à ruban
Screw wrench	*clef* à écrou
Axle wrench	*clef* d'essieu
Anvil	*enclume*
Portable forge	*forge* portative
File	*lime*
Tool	outil
Wheel jack	*chèvre*
Materials—	
Emery paper	papier émerisé
Glass paper	papier verré
Oil	*huile*
Grease	*graisse*
Glue	*colle forte*

[1] Feminine Nouns in italics.

English.	French.[1]
Paste	*pâte*
Pencil	pinceau
Paint / Colour	*couleur*
Varnish	vernis
Putty	mastic de vitrier
Linseed oil	*huile* de lin
Turpentine	*térébenthine*
Brush	*brosse*
Chamois leather	*peaux* de chamois
Felt	feutre

Colours—

Brown	brun
Vermilion	vermillon
Red	rouge
Indian red	rouge indien
Blue	bleu
Ultramarine	bleu d'outremer
Indigo	indigo
Green	vert
Olive green	vert olive
Emerald green	vert emeraude
Grey	gris
White	blanc

Woodwork Joints—

Mortise	*mortaise*
Tenon	tenon
Mitre	ouglet
Mitre joint	assemblage d'onglet
Mortise joint	assemblage à *mortaise*
Dovetailing	assemblage à queue d'aronde
Lapping	recouvrement
Dowel	goujon
Tongue	*languette*
Wedge	coin, *cale*
Cleat	toquet
Rebate	*feuillure*

Terms used in the Trimming Shop—

Trimmer	garnisseur
Trimming shop	atelier de garnissage
Trimming	garnissage
Inside handle (lever)	*bascule*
Door pull (pulling handle)	*poignée* de tirage

[1] Feminine Nouns in italics.

ENGLISH.	FRENCH.[1]
Glass string slide or roller	*roulette* de *glace*
Lever slides	*plaque* de *serrure*
Garnish plate (lock plate)	*plaque* de *serrure*
Olive	*olive*
Lever knob (lock knob)	bouton de *serrure*
Glass string guard (string guard)	porte-cordon
Ratchet (of blind)	cric
Lifting jack (of C spring)	cric
Eyelet	œillet
Screw eyelet	œillet à vis
Spring roller blind	store
Acorn or tassel	gland
Shaft point	bout de brancard
Companion	cantine
Hammercloth	housse
Apron guard	*douille* à vis pour tablier
Head	*capote*, soufflet (bellows)
Folding head	*capote* ployante
Extension head	*capote* à extension / *capote* extensible
Head up	*capote* tendue
Head down	*capote* repliée / *capote* rabattue
To strike the head	de faire factionner la *capote*
Sticks (of head)	cerceaux
Dust shield	pare-poussiere
Sliding front stick	cerceau d'avant surélevé
Head joints	compas
Stump	goujons de compas
Props	goujons de caisse
Cushion	coussin
Neck plates	eventails
Fingers	eventails
Outside joints	compas exterieurs
Straight joints	compas droit
Strap	*courroie*
Arm sling	*brassière*
Window blind	store
Curtain	rideau
Carpet	tapis
Ladder	*échelle*
Electric light	éclairage electrique
Upholstered	garni
Leather	cuir
Spring seat	siege à ressorts
Hair seat	siege en crin

[1] Feminine Nouns in italics.

English.	French.[1]
The distance or spreading between the sticks	l'ecartement entre les cerceaux
Front stick	cerceau d'avant
Cornice	*gouttière*
Seat back	dossier
Silk	*soierie*
Silk goods	*soierie*
French nail	*pointe* de Paris
Tack	petit clou
Wood screw	*vis* en bois
Ring and hook	anneau et crochet
Pulley	*poulie*
Check string (string of coachman)	cordon de cocher
Curtain end fitting	piton
Curtain spike	piton
Screw hook for hat rack	piton pour chapelière
Check string conductor	*canule* pour cordon de cocher
Speaking tube conductor	*canule* pour cordon acoustique
Speaking tube	cordon acoustique
Glass frame riser	lève-glace
Hat rack (cord hat rack with cross pieces)	*chapelière* en cable avec traverses
Parasol hook	crochet *d'ombrelle*
Umbrella hook	crochet de parapluie
Window lift (sash hook)	crochet de *châsse*
Velvet pile or Wilton carpet	*moquette*
Broad lace	galon large
Seaming lace	galon couture
Pasting lace	galon rabattre
Piping	galon passepoil
Lace goods	*passementerie*
Horse hair	crin
Whip socket	etiu de fouet
String, thread, cord	*ficelle, corde,* cordon vil
Glazed calico	*percaline,* treilles
Cane	rotin
Bone	os
Buffalo (horn)	buffle
Needle	*aiguille*
Wing	*aile*
Wing (mudguard)	garde-boue
Wood wing	*aile* en bois
Sheet (iron) wing	garde-crotte *en tole*
Dashboard	garde-crotte en bois

[1] Feminine Nouns in italics.

English.	French.[1]
Timber—	
Wood	bois
Timber	bois de construction
Coach timber (joinery wood)	bois de *menuiserie*
Wood for wheelwrights	bois de charronage
Wood for framing	bois de *charpente*
Hardwood	bois dur
Deal	bois blanc
Unhewn timber	bois en état
Logs	bois gisant
Rough hewn timber	groissièrement équarri / dressé à la *hache*
Seasoned timber	bois desséché
Bent timber	bois cêntrés
Knot	nœud
Sapwood	aubier
Oak	chêne
Elm	orme
Wych elm	orme tilleul
Walnut	noyer
Beech	hêtre
Ash	frêne
Teak	teck, tex
Mahogany	acajou
Greenheart (hard bay-tree or laurel-wood)	bois laurier dur
Spruce	*épinette*
Pine	pin
Poplar	peuplier
Birch	bouleau
Lime tree	tilleul
Plane tree	platane
Rosewood	palissandre
Across the grain	dans le travers
With the grain	dans le sens
Metals—	
Steel	acier
Cast steel	acier fondu
Sheer steel	acier corroyé
Wrought iron	fer soudé
Bar iron	fer en bottes
Sheet iron	fer battu non étainé
Brass	laiton
Stamping	estampeur

[1] Feminine Nouns in italics.

English.	French.[1]
Parts of the Vehicle—	
Wheel	*roue*
Door	*portière*
Door pillar	montant de porte
End or corner pillar	montant de bout
Footboard / Long side step	marchepied
Body	caisse
Roof	*impériale*
Raised roof / Clerestory	plafond surélevé
Light / Glass	*glace*
Door panel	panneau de *porte*
Seat board	*planches* du siège
Roof board	*planches* de *toiture*
Seat	banc siège
Tip-up seat	baquet basculant
Axle	essieu
Straight axle	essieu droit
Crank axle	essieu coudé
Live axle	essieu moteur
Axle arm	*bielle*
Nave / Hub / Stock	moyeu
Axle box (grease box)	*boîte* à *graisse*
Spoke	rais
Felloe	*jante*
Moulding	*moulure*
Pole	timon
Pole head	crapaud de timon
Brake	frein
Brake lever	levier de frein
Shackle	chaîne
Tyre	bandage
Tyre bolt	boulon d'attache du bandage
Perch bolt	*cheville ouvriere*
Elliptic spring	ressort elliptique
Lamp	lampe
Head lamp	feu d'avant
Tail lamp	feu d'arrière
Footwarmer (hot water)	bouillotte
Footwarmer	chaufferette
Ventilator	ventilateur

[1] Feminine Nouns in italics.

English.	French.[1]
Door handle	bouton de *porte* *poignée* de *portière*
Lock	*serrure*
Wheelbase	empattement
Hand brake	frein à *main*
Screw brake	frein à *vis*
Brake connecting rod	tige de commande de la *timonerie*
Brake block Brake shoe	sabot
Horn	cornet
Victoria with removable driving seat and dickey	mylord a deux sièges mobiles
Two-seated body with box behind	voiture à deux places, avec coffre arrière
Side-entrance double phaeton	double phaeton à *entreés* latérales

[1] Feminine Nouns in italics.

APPENDIX E

SPECIMEN OF A CLASS LESSON DEALING WITH STRENGTHS AND STIFFNESS OF MATERIALS

MOTOR BODY BUILDING—MUNICIPAL TECHNICAL COLLEGE, BRIGHTON.

STRENGTHS AND STIFFNESS OF MATERIALS.

How to find the safe loading weight that may be applied to timber and iron, which is used by the bodymaker, especially useful in the construction of Commercial bodies.

Example :—What is the safe central dead load for an oak beam 12 in. square, resting on supports 9 ft. apart ?

$$\text{Formula : } W = \frac{4\ S\ R}{l}.$$

Solutions :—

W = Safe working load, in lb.
S = Safe strength of material in bending (see Table III).
R = A factor (see Table IV).
l = Length of beam, or distance between supports.

$$W = \frac{4 \times \frac{S\ b}{f} \times \frac{b\ h^2}{6}}{l}; \quad = W = \frac{4 \times \frac{6{,}200}{8} \times \frac{12 \times 12^2}{6}}{108};$$

$$W = \frac{4 \times 6{,}200 \times 12 \times 12 \times 12}{8 \times 6 \times 108}; \quad W = \frac{4 \times 6{,}200 \times 12 \times 12 \times 12}{8 \times 6 \times 108} = \frac{24{,}800}{3}.$$

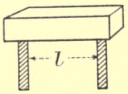
(Cancellation) 4, 2, 4, 4, 4, 9, 3

$$\frac{24800}{3} = 3{,}267 \text{ lb.} = \text{Approximately } 3\tfrac{3}{4} \text{ tons.} \quad \text{Ans.}$$

I. FACTOR OF SAFETY.

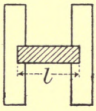
Material.	Steady or dead load.	Sudden load or shock.
Timber	8	14
Steel or wrought iron	4	7

II. Formulæ for Strengths of Beams.



$$W = \frac{4\ S\ R}{l}:$$

Resting on supports.



$$W = \frac{8\ S\ R}{l}.$$

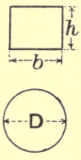
Built into standing pillars.

III. Safe Strengths of Bending.

The value of S is found from the formula $S = \frac{S\,b}{f}$; (see below) which is for the materials under consideration, f from I. This depends on the manner in which the weight is applied.

Cast iron	30,000 lb. per sq. in.	Oak	6,200 lb. per sq. in.	$= S\,b.$
Wrought iron forgings	48,000 ,,	Pitch pine	5,800 ,, ,,	
Mild steel forgings	70,000 ,,	Teak	7,500 ,, ,,	

IV. Value of R in Formula.



Section of material. $\frac{b\,h^2}{6} = \frac{\text{breadth} \times \text{height}^2}{6}$.

Do. $\frac{A\,D}{8} = \frac{\text{area in sq. in.} \times \text{diameter}}{8}$.

Area of circle $= r^2\pi$; that is radius $^2 \times 3{\cdot}1416 =$ sq. in. (or $D^2 \times {\cdot}7854$).

Example.

What would be the weight of this beam? Specific gravity, ·77.

Solution:—

The Standard, which is water = 62·5 lb. per cu. ft. at 39·1 F.

Beam, 12 in. × 12 in. × 108 in. = 15,552 cu. in. ÷ by 1,728 = 9 cu. ft. 62·5 × ·77 = 48·125 lb. 48·125 lb. weight of cu. ft. of oak × 9 = 433·125 lb. Ans. 434 lb.

A solid rectangular wrought iron beam, 6 in. deep and 3 in. wide, rests on two supports 8 ft. apart. What dead load, applied at the middle, will it safely support?

$$W = \frac{4\ S\ R}{l}, = W\ \frac{4 \times \frac{S\,b}{f} \times \frac{b\,h^2}{6}}{l}.$$

$$W = \frac{4 \times \frac{48{,}000}{4} \times \frac{3 \times 6 \times 6}{6}}{96}.$$

$$W = \frac{4 \times 48{,}000 \times 3 \times 6 \times 6}{4 \times 6 \times 96}$$

$$W = \text{(By cancellation)}\ \frac{\overset{1,200}{\cancel{4}\times\cancel{4{,}800}}\ \times\ \overset{1}{\cancel{3}}\ \times\ \overset{3}{\cancel{6}}\ \times}{\underset{\cancel{24}}{\cancel{4}\times\cancel{6}\times\cancel{96}}\ \underset{4}{\cancel{8}}} = \frac{36{,}000}{4}\ \text{lb.}$$

$$\frac{36{,}000}{4} = 9{,}000\ \text{lb.} \div 2{,}240 = 4\ \text{tons, Ans.}$$

What would be the weight of this beam?

Specific gravity of wrought iron = 7·63

Beam, 3 in. × 6 in. × 96 in. = 1,728 cu. in., which equals just 1 cubic ft.

62·5 lb. (The Standard) × 7·63 = 476·875 lb. { (Weight of 1 cu. ft. of wrought iron.)

Ans. 477 lb.

APPENDIX F

MEASUREMENT OF TIMBER

The Rule on page 18 gives the approximate amount of usable wood, and is the usual trade practice. It allows nearly 25 per cent. for waste, which includes the bark, etc. This method of measuring is considered to be advantageous from the buyer's point of view. If the solidity of the tree is required, the following formula must be applied:

$$v = r^2 \pi l.$$

that is:
volume = the radius of the "average diameter" squared, multiply by 3·1416, multiply by the length of the tree. This must be done in inches, and the result will be cubic inches; divide this by 1,728 to bring it to cubic feet.

The radius is half the diameter.
The diameter multiplied by 3·1416 gives the circumference.
The Greek symbol π or $\bar{n}$ (pi) denotes 3·1416.

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Butler & Tanner Frome and London